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The research described in this report had two purposes: First, to determine if meaning change and paraphrase test sentences (which are two of the test item types in the Sentence Verification Technique of measuring reading comprehension) could be used to assess and examinee's capacity to store information that had been read and to retrieve information that had been previously stored, and second, to evaluate two procedures that could enhance the reliability of SVT tests. The two procedures were a new form of the Sentence Verification Technique called the Meaning Identification Technique and asking examinees to rate their confidence in responses to test items. *Keywords: paraphrase, SVT*

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Dr John F. Tangney

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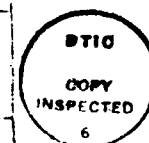
## Using the Sentence Verification Technique

**James M. Royer & Gale M. Sinatra**

University of Massachusetts, Amherst

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### Summary

The research described in this report had two purposes: First, to determine if meaning change and paraphrase test sentences (which are two of the test item types in the Sentence Verification Technique of measuring reading comprehension) could be used to assess an examinee's capacity to store information that had been read and to retrieve information that had been previously stored, and second, to evaluate two procedures that could enhance the reliability of SVT tests. The two procedures were a new form of the Sentence Verification Technique called the Meaning Identification Technique and asking examinees to rate their confidence in responses to test items.

Six studies were conducted to evaluate these two purposes. The purpose of Experiment 1 was to determine if an effect of activating a schema could be obtained with the subjects and facilities at the LAMP facility at Lackland Air Force Base. In the experiment, subjects read a passage describing the activities of two boys playing hooky from school, and they then recalled everything they could remember from the passage under three kinds of instructions designed to activate (or not activate) a schema. One group received schema activating instructions prior to reading the passage, another group received schema activating instructions after reading but prior to recall, and a third control group read and recalled the passage without schema activating instructions. The results of the study indicated that subject recall did vary as

a function of schema activation, though the effect was not as substantial as in previous studies.

The purpose of Experiment 2 was to test the hypothesis that meaning change and paraphrase SVT test items provided indices of an examinees ability to store and recall text information. Experiment 2 used the same passage as was used in Experiment 1 and entailed essentially the same instructions to subjects as was used in Experiment 1 (schema activation prior to reading, after reading and prior to testing, and no instructions), but instead of free recalling the text, examinees took either an SVT test or an MIT test. The study produced the predicted interaction between nature of passage sentences and type of SVT test item, but the interaction was in the opposite direction to that which was predicted!

The purpose of Experiment 3 was to determine whether recall of a passage would correspond to a Bonnie Meyer text analysis of the passage. Meyer's text analysis procedure identifies levels of passages and previous research has shown that material high in a text hierarchy is typically recalled better than material low in a text hierarchy. Subjects at the LAMP facility read and recalled a passage concerned with static electricity. The results were opposite to those predicted by Meyer's procedure. That is, subjects were better at recalling material low in the hierarchy than they were at recalling material high in the hierarchy. Several reasons were suggested for this result.

Experiment 4 was again designed to evaluate the storage/retrieval hypothesis for SVT test items. LAMP subjects read the same passage used in Experiment 3 and then took SVT and MIT tests on the passage. The results were contrary to those predicted on the basis of the Meyer text analysis, but they were consistent with the recall results from Experiment 3.

Experiments 5 and 6 were concerned with evaluating the psychometric properties of MIT tests and tests in which subjects rated confidence in their test responses relative to traditional SVT tests and traditional procedures for administration. The results of the studies showed that both SVT tests and MIT tests had very low reliabilities (probably associated with truncated score distributions). However, Experiment 6 also produced evidence that asking subjects to rate their confidence in their responses improved the reliability of both SVT and MIT tests.

The report concludes with a general discussion and with general comments regarding the reliability of SVT tests in general. The results of the experiments concerned with the hypothesis that meaning change and paraphrase test sentences could provide indices of an examinee's ability to store and retrieve text were not consistent with predictions derived from schema theory and from Meyer's research on text hierarchies. However, paraphrase and meaning change sentences did interact with experimental variables and it is still possible that the two types of items are assessing different cognitive capacities.

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## Introduction

The research described in this document was designed to evaluate two issues: First, whether performance on different item types in a recently developed procedure for measuring reading and listening comprehension are indices of an examinee's ability to store and subsequently retrieve verbal information from memory, and second, whether a new form of the measurement technique has superior psychometric properties relative to the old. The report is divided into several sections. The first section will describe the new measurement technique that provides the focus for the research to be reported. Sections to follow will describe the issues evaluated in the research project, the results of the project and a discussion of those results.

### The Sentence Verification Technique

The Sentence Verification Technique (SVT) is a recently developed procedure for measuring reading and listening comprehension. The technique entails developing one of four types of test sentences to represent each sentence in an original passage. The first of the four test sentence types is an original which is a copy of a sentence as it appeared in the passage. The second type of test sentence is a paraphrase which is developed by changing as many words in an original sentence as possible without altering the meaning of the sentence. The third type of test sentence is a meaning change which is an original sentence with one or two words changed so that the meaning of the sentence is different. The final type of test sentence is a distractor

which is a sentence that is similar to a passage sentence in syntax and vocabulary level and that is consistent with the general theme of the passage but the sentence is unrelated to any sentence appearing in the passage.

An SVT test consists of an equal mix of each of the test sentence types. An examinee takes an SVT test by reading a passage and then responding "old" or "new" to the test sentences without returning to the passage. Old sentences are defined as sentences that are the same as or mean the same as a passage sentence (originals and paraphrases) and new sentences are defined as sentences that have a different meaning than passage sentences (meaning changes and distractors). A considerable amount of evidence regarding the reliability and the validity of the SVT has accumulated to this point. This evidence suggests that the SVT is both a reliable and a valid measure of comprehension (Rasool & Royer, 1986; Royer, 1986; Royer & Hambleton., 1983; Royer, Abranovic & Sinatra, in press; Royer, Hastings, & Hook, 1979; Royer, Kulhavy, Lee & Peterson, in press; Royer, Lynch, Hambleton & Bulgarelli, 1984; Royer, Marchant, Sinatra & Lovejoy, 1986).

#### Measuring Storage and Retrieval Processes

Several studies have shown that it is possible to independently manipulate storage and retrieval processes either through instructions to subjects or through manipulations of text characteristics (e.g. Anderson & Pichert, 1978; Anderson, Pichert, & Shirey, 1983; Britton, Meyer, Hodge, & Glynn, 1980; Pichert & Anderson, 1977). The demonstrations that storage and retrieval

can be independently manipulated raises the possibility that the two might be separable individual difference variables. In many instances involving instruction from text there are two reasons for performance failures: initial failure to store material to be learned and failure to recall previously stored information. It is possible that individuals experiencing problems in learning from text (or particular types of text) consistently experience one or the other of these problems. The research to be reported evaluated whether two of the item types in Sentence Verification Technique tests provide separable assessments of a reader's ability to store and retrieve text information.

Background for research. The research that provides the impetus for the present research effort began with two studies by Royer, Marchant, & Sawula (1986) that were designed to examine performance on the different SVT test sentence types as a function of the position of a passage sentence in a hierarchical analysis of the passage. The passages used in the studies had been analyzed using both Meyer's (e.g., 1975) and Kintsch's (e.g., 1974) text analysis systems. Previous research (e.g., Meyer, 1975) has found that hierarchical position is predictive of a reader's ability to recall a sentence after reading the passage. That is, sentences having considerable importance in a passage (e.g., main idea sentences) were recalled with greater frequency than sentences concerned with trivial detail. The results of previous studies suggest that hierarchical position in a passage is an important determinant of the recall of a sentence, but there is also

evidence that hierarchical position does not predict a reader's performance in recognition tasks (e.g., Britton, Meyer, Hodge, & Glynn, 1980).

With this background in mind, we can now return to the Royer, Marchant, and Sawula (1986) studies. They found that performance on meaning change test sentences did vary as a function of a passage sentence's position in a hierarchy (i.e., sentences high in the hierarchy were responded to with greater accuracy than those low in the hierarchy), but that performance on paraphrase test sentences was not influenced by hierarchical position (i.e., there was no difference in accuracy of responding to sentences high and low in the hierarchy).

The pattern of results described above suggests the hypothesis that responding to paraphrase sentences involves a recognition process in which the meaning of a test sentence is directly compared (through recognition) with the meaning of a memory representation established when reading the original passage, and that responding to meaning change sentences involves a recall process in which a stored memory representation is retrieved before it is be compared to the test sentence. This interpretation received additional support in a second study conducted by the same investigators.

Since the ability to recognize previously encountered material is extraordinarily good even after long delays (e.g., Teghtsoonian & Shepard, 1967) performance on recognition tasks is commonly assumed to indicate whether information was initially

stored. Thus, if the hypothesis suggested in the preceding paragraph were true, performance on paraphrase test sentences could provide an index of an examinee's ability to store a meaningful representation of a text. Moreover, performance on recall tasks is assumed to measure ability to retrieve information from memory. Since performance on meaning change sentences appears to be sensitive to variables that influence recall of text, they may provide an index of an examinee's ability to retrieve information from text given that it had been stored.

#### Evaluating the Psychometric Properties of a new form of the SVT

In a previous project conducted under the auspices of AFHRL (Tirre, Royer, Greene, & Sinatra, 1987; Royer, Tirre, Sinatra, & Greene, in submission) SVT tests were evaluated as indices of on-line comprehension in a computer-based instruction environment. The SVT tests in that project had relatively low reliabilities. In the final project report several procedures for improving the reliability of SVT tests were suggested. These suggestions included using a new version of SVT tests and collecting confidence ratings on responses. Each of these techniques will be briefly described.

Marchant, Royer & Greene (in press) have reported a study in which a new version of SVT tests had better reliability and validity than did traditional versions. The new version, which is called the Meaning Identification Technique (MIT), entails the development of two types of test items rather than the four item types contained in the traditional version. The item types

contained in the MIT are paraphrases and meaning change paraphrases. Test items are developed by writing paraphrases for each of the sentences in an original passage and making meaning changes out of half of the paraphrases. Given the results of Marchant et al. (in press), the present research examined the use of MIT tests as a means of improving the reliability of SVT tests.

The second technique for improving reliability suggested in the final report for the previous project involves having the examinee rate their confidence in their decision as to whether an SVT test sentence is old or new. The idea is that confidence ratings could discriminate between an examinee who knows with certainty that test sentences have a different meaning than passage sentences and an examinee that has an inkling that the test sentence and passage sentence differ in meaning. These finer grained distinctions could improve the reliability of the tests.

The research to be reported evaluated both the MIT and the use of confidence ratings as a means of enhancing the reliability of SVT tests.

#### Rationale and Hypotheses for Experiments

Separating storage from retrieval is a particularly thorny issue and additional support must be obtained before the conclusion would be justified that different SVT item types separately assess ability to initially store a text representation and to then recall that representation at a later time. Four experiments were conducted that could provide the evidence to support the hypothesis.

One way of evaluating the possibility that different SVT item types assess storage and retrieval capabilities would be to independently manipulate the likelihood of the storage and retrieval of a text using the Anderson and Pichert perspective paradigm (Anderson & Pichert, 1978; Anderson, Pichert, & Shirey, 1983; Pichert & Anderson, 1977). The perspective studies have shown that subjects given a perspective at the time of reading a text tend to be able to only recall material consistent with the perspective they have been given. In contrast, when subjects are instructed to keep a perspective in mind at the time of recall, they tend to recall material consistent with the perspective they have been given, but they can recall additional material when asked to shift perspectives. These results suggest that perspective instructions given at the time of reading influence the likelihood of storage of material whereas perspective instructions given at the time of recall influence the likelihood of retrieval of information. If this interpretation is correct, and if the results from the Royer, Marchant, and Sawula (1986) studies are replicable, instructions given at the time of reading could be expected to influence performance on both paraphrase and meaning change sentences. Alternatively, instructions given at the time of retrieval would be expected to influence meaning change performance but not paraphrase performance.

The perspective paradigm provided the basis for the first two experiments in the present research effort. Experiment 1 is essentially a replication of the Anderson and Pichert research.



The purpose of the replication is to establish that the perspective effect will occur with the materials and subjects used in the present research. Experiment 2 entailed having subjects read passages and take SVT tests under various perspective instructions and provided a test of the storage and retrieval hypothesis as it relates to the measurement properties of paraphrase and meaning change items.

The third and fourth experiments entailed having subjects read a passage that contained material that was high and low in a Meyer text analysis hierarchy (e.g., 1976). After reading the passage the subjects either recalled the passage (Experiment 3) or responded to SVT questions (Experiment 4) based on the passage. The end of passage test was arranged such that half of the paraphrase items and half of the meaning change test items assessed material that was high and low in a Meyer text analysis hierarchy.

If the storage/retrieval hypothesis is correct, the hierarchical position of a sentence should influence performance on meaning change sentences to a greater extent than performance on paraphrase sentences. This result would provide a replication of the results found by Royer, Marchant, & Sawula (1986) with the longer passages used in the third and fourth study.

The research will be reported as 6 separate experiments but it should be noted that the studies were actually run within the same time frame and in some cases the same subjects participated in two experiments.

## Experiment 1

### Method

Design and subjects. The purpose of Experiment 1 was to determine if the perspective shift effect would be found with the materials and subjects used in the present study. The first variable in the experiment was perspective instructions. The subjects who received the perspective instructions were told to "think about the story from the perspective of a burglar" either prior to reading the passage (before reading) or at the time of recall (after reading). The subjects in the control condition were instructed to read the passage carefully. The second variable in the experiment was a within-subject variable that indexed whether passages sentences were relevant or irrelevant with respect to the perspective instructions. Thus the complete design was a 3(before, after, control) X 2(relevant, irrelevant) analysis of variance design.

The subjects were Air Force enlistees completing basic training at Lackland Air Force Base. Thirty subjects were assigned to the before perspective condition, 29 were assigned to the after perspective condition, and 28 were assigned to the control condition.

Materials. The passage used in Experiment 1 was an adaptation of the passage used in Kardash, Royer, and Greene (in press), which in turn was an adaptation of the burglar/homebuyer passage used in the Pichert and Anderson (1977) perspective study. The burglar/homebuyer passage developed by Kardash et al. (in

press) contained 511 words and 26 sentences. Thirteen sentences provided information relevant to homebuyers, while another 13 provided information relevant to burglars. A copy of the passage and the SVT test items is contained in Appendix A of this report. Kardash et al. (in press) obtained norming data on each of the sentences in the passage and the eight sentences that were judged to be most "burglar-relevant" and the eight judged to be least "burglar relevant" were of particular interest in the study.

Procedure. Subjects were seated at individual computer testing stations. All instructions and information were presented on the computer. Subjects were first given a general orientation to the system which included a keyboard exercise. Then subjects in all three conditions were given the following instructions:

"The purpose of this study is to see what people remember about stories they have read. During the computer session you will read one paragraph of a passage at a time and then, after you have read the entire passage, you will be asked to remember what you read."

Subjects were given perspective instructions according to condition. Those subjects in the perspective before condition were told prior to reading the passage:

"When you read the passage, think about the story from the perspective of a burglar. In other words, consider

each sentence in the story in light of its interest to a burglar."

Subjects in the perspective after condition were given the following instructions after having read the passage:

"As you are recalling the passage, think about the story from the perspective of a burglar. In other words, consider the information in the story in light of its interest to a burglar."

Subjects in the control condition were simply asked to write down everything they could remember from the story. The passage was presented one paragraph at a time. Subjects read at their own pace and reading time per paragraph was recorded. Subjects in all conditions were allowed approximately 10 minutes for written recall of material.

Scoring. The passage was divided in 112 idea units. (See Appendix C.) This was the same list of idea units used in Kardash et al. (in press). Two raters independently scored each recall protocol. Reliability (calculated as percent agreement between the two raters) was 75%. All discrepancies were resolved to yield a final percent agreement of 100%.

### Results

The means and standard deviations for the experiment are presented in Table 1. The data from the experiment was analyzed using a MANOVA procedure in which the independent variable was perspective instructions (before, after, control) and the

dependent variables were recall of relevant and irrelevant sentences. The analysis indicated a significant main effect for perspective instructions,  $F(2,84)=12.3$ ,  $p < .01$ . As can be seen in Table 1, subjects in the control condition recalled more than the two perspective conditions and subjects in the perspective before condition recalled more than subjects in the perspective after condition. The analysis also revealed a main effect for sentence relevance,  $F(1,84)=60.4$ ,  $p < .01$ . Inspection of Table 1 will show that subjects recalled more burglar relevant information than they did burglar irrelevant information.

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Insert Table 1 About Here

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The most interesting aspect of the data was whether perspective instructions would interact with sentence relevance. The perspective effect would be evident if instructions to either read or recall the story under the influence of the burglar perspective resulted in greater recall of burglar relevant information than burglar irrelevant information. The data analysis did reveal a significant interaction between perspective instructions and sentence relevance,  $F(2,84) = 10.6$ ,  $p < .01$ . The nature of this analysis was further elucidated in a series of post-hoc comparisons. In both the perspective before condition and the perspective after condition subjects recalled significantly more perspective relevant information than they did perspective irrelevant information,  $F(1,84)= 9.2$ ,  $p < .01$ , and

$F(1,84) = 67.7, p < .01$ , respectively. However, it was also the case that subjects in the control condition recalled more relevant information than irrelevant information,  $F(1,84) = 4.9, p < .05$ , though as Table 1 indicates the difference between recall of relevant and irrelevant material was smaller in the control group than it was in the two perspective groups.

### Discussion

The purpose of Experiment 1 was to determine if the perspective effect could be found using the materials, subjects, and conditions available at the LAMP testing facility. The results were not unequivocal, but they did indicate a trend toward reproduction of the perspective effect. Subjects in the two perspective conditions did recall significantly more perspective relevant information than perspective irrelevant information. However, the control subjects also recalled more relevant information than irrelevant information. An inspection of the means in Table 1 and the results of the statistical analyses indicates, however, that the difference between relevant information recalled and irrelevant information recalled was greater in the two perspective conditions than it was in the control condition. Thus, the trend in the data was toward replication of the perspective effect.

### Experiment 2

The purpose of Experiment 2 was to evaluate the SVT storage/retrieval hypothesis using the materials and procedures evaluated in Experiment 1. Given that there was evidence from

Experiment 1 that the perspective effect could be found (even though this evidence was not conclusive) using the LAMP facilities, Experiment 2 was designed to assess whether paraphrase SVT sentences measured an examinee's ability to store information that had been read and meaning change sentences measured an examinee's ability to recall information that had been previously stored. Evidence supporting these hypotheses would be present if subjects under perspective instructions before reading performed better on both paraphrase and meaning change relevant test sentences (compared to performance on irrelevant test sentences). In comparison, the expectations in the perspective after condition would be that subjects would perform better on relevant meaning change sentences compared to irrelevant meaning change sentences, but there would not be a difference in performance on relevant and irrelevant paraphrase test sentences.

A second purpose of Experiment 2 was to compare the psychometric properties of SVT tests with those of MIT tests. One-half of the subjects in the experiment read a passage and then took an SVT test on the passage, the remaining half of the subjects read the same passage and took an MIT test.

### Method

Design and Subjects. Three between subject and two within subject variables were manipulated in the experiment. The first between subject variable was perspective instructions which was manipulated in the same manner as in Experiment 1. Subjects received burglar perspective instructions either before reading

the passage ("think about the story from the perspective of a burglar. In other words, consider each sentence in the story in light of its interest to a burglar."), after reading the passage (" when beginning the test, think about the passage you read from the perspective of a burglar. While taking the test, consider each test sentence in light of its interest to a burglar.") or they received no perspective instructions (control). The second between subject variable was type of test. Subjects took either an SVT test or a MIT test after reading the passage. The first within subject variable was relevance of passage sentence. The same eight sentences classified in Experiment 1 as relevant to the burglar perspective and the eight sentences classified as irrelevant to the burglar perspective were used in Experiment 2.

The second within subject variable was test item type. Half of the relevant sentences were tested with paraphrase test items and half were tested with meaning change test items (in the case of MIT tests, these were meaning change paraphrases). Likewise, half of the irrelevant sentences were tested with paraphrase test sentences and half were tested with meaning change test sentences.

The final between subject variable in the experiment was test version. In order to balance sentence relevance with test item type, two versions of the SVT and MIT tests were prepared. If one were to imagine the eight relevant and irrelevant sentences being numbered one through eight, in test version one the even numbered sentences would be tested by paraphrase test sentences and the odd



numbered test sentences would be tested by meaning change test sentences. In test version two this procedure would be reversed with the even numbered sentences tested by meaning change test sentences and the odd numbered sentences tested by paraphrase test sentences. Thus the complete design was a 3(before, after, control perspective instructions) X 2(SVT or MIT tests) X 2(test version 1 or 2) X 2(relevant or irrelevant passage sentences) X 2(paraphrase or meaning change test sentence type) ANOVA design with the first three variables being manipulated between-subjects and the last two variables being manipulated within-subject.

Two-hundred-twenty Air Force enlistees were randomly assigned to the twelve between-subject conditions in the study. For some unknown reason the distribution of subjects to condition was not very even. The number of subjects in each of the twelve conditions was 21, 8, 21, 15, 21, 20, 21, 20, 21, 21, 20, 20.

Materials. The passage used in the experiment was the same as was used in Experiment 1. The SVT tests based on the passage were developed in accordance with the guidelines described in Royer, Sinatra, and Greene (1987). The complete process involved several stages. First, the eight most burglar-relevant sentences in the passage (as established by Kardash et al.) were selected and four paraphrase test sentences and four meaning change test sentences were developed from these sentences. This procedure was reversed (i.e., sentences tested with paraphrases were tested with meaning changes and vice versa) for test version 2. A similar procedure was used to develop test sentences for the eight most

irrelevant test sentences. The remaining twelve sentences in the passage were tested with original and distractor test sentences. The original and distractor test sentences were identical for both test version 1 and test version 2.

The MIT tests were prepared by first writing paraphrase test sentences for each sentence in the passage and then converting half of the test sentences to meaning change paraphrases. The SVT test served as a pattern for the development of the MIT. That is, sentences tested with paraphrases in the SVT were tested with paraphrases in the MIT and sentences tested with meaning changes in the SVT were tested with meaning change paraphrases in the MIT. In version 2 the procedure was reversed with the odd-numbered sentences tested with meaning change paraphrases and the even numbered sentences tested with paraphrases. The remaining 12 sentences in the passage were tested with an equal mix of paraphrases and meaning change paraphrases. These test sentences were identical in both versions of the test.

Procedure. Subjects were seated at individual computer testing stations. All instructions and information were presented on the computer. Subjects were first given a general orientation to the system which included a keyboard exercise. Then subjects in all three conditions were given the following instructions:

"The purpose of this study is to see what people remember about stories they have read. After reading the passage that will be presented below, you will be

given a series of test sentences. Your task will be to judge whether the meaning of each test sentence is the same or difference from a sentence that you read in the passage. During the computer session you will read one paragraph of a passage at a time and then, after you have read the entire passage, you will receive test sentences one at a time."

A practice paragraph and four practice test sentences were then presented. Subjects in the SVT test conditions received SVT practice items, and subjects in the MIT conditions received MIT practice items. After the practice test items, subjects received perspective instructions according to condition. Those subjects in the perspective before condition were told prior to reading the passage:

"When you read the following passage, think about the story from the perspective of a burglar. In other words, consider each sentence in the story in light of its interest to a burglar."

Subjects in the perspective after condition were given the following instructions after having read the passage:

"When beginning the test, think about the passage you read from the perspective of a burglar. While taking the test, consider each test sentence in light of its interest to a burglar."

Subjects in the control condition were simply instructed to respond to the test sentences as they had been instructed in the

practice exercise. Subjects in all conditions were reminded how to respond to test sentences. The passage was presented one paragraph at a time and subjects read at their own pace. Reading times per paragraph were collected. Test sentences were presented one at a time. Responses and response times for each test sentence were also collected.

### Results

Experimental results. The means and standard deviations for the experiment are contained in Table 2. The Experiment was analyzed using a MANOVA procedure in which the independent variables were perspective instructions (3 levels), type of test (2 levels), test version (2 levels), sentence relevance (2 levels), and test item type (2 levels). The dependent variable in the analysis was the number of relevant and irrelevant test sentences (both paraphrase and meaning change) that each subject got correct out of the four possible correct. The effects for perspective treatment, test type, and test version were nonsignificant. Subsequent analyses collapsed over test type and test version.

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Insert Table 2 About Here

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The MANOVA revealed a main effect for sentence relevance with test sentences based on irrelevant passage sentences correct more frequently than test sentences based on relevant sentences (means = 3.17 vs. 2.98, respectively),  $F(1,217) = 11.6$ ,  $p < .01$ . There was

also a main effect for test item type with meaning change sentences being correct more frequently than paraphrase test sentences (means = 3.2 and 2.95, respectively),  $F(1,217) = 19.7$ ,  $p < .01$ . Finally, there was a significant interaction between sentence relevance and test item type,  $F(1,217) = 9.9$ ,  $p < .01$ . The nature of this interaction was that there was a larger difference between irrelevant paraphrase and meaning change test sentences (means = 2.96 and 3.38, respectively) than there was between relevant paraphrase and meaning change test sentences (means = 2.95 and 3.01, respectively).

#### Psychometric Results

The results related to the psychometric properties of the tests will be reported as Experiment 5.

#### Discussion

Evidence in support of the storage/retrieval hypothesis would have been forthcoming if perspective instructions had influenced performance on meaning change test sentences in both the perspective before and the perspective after conditions and if perspective instructions influenced performance on paraphrase test sentences only in the perspective before condition. In other words, subjects were expected to perform better on the relevant meaning change test sentences (compared to performance on irrelevant sentences) in both the perspective before and after conditions, but they were expected to perform better on the relevant paraphrase test sentences only in the perspective before condition.

The results of the experiment were not consistent with these expectations. As can be seen in Table 1, the pattern of performance on the relevant and irrelevant test sentences is remarkably consistent across all three perspective conditions. There is virtually no difference on paraphrase test sentences between relevant and irrelevant test sentences in each of the perspective conditions (including the control condition). There is a difference between relevant and irrelevant test sentences on the meaning change test sentences, but that difference is in the wrong direction. That is, subjects have better performance on irrelevant sentences than they do on relevant sentences.

A close inspection of the data in Table 1 suggests the interpretation that the test item type by sentence relevance interaction is a result of differences between the specific paraphrase and meaning change items used in the study. Notice that the pattern of performance in the control condition is identical to that for the two perspective conditions. This suggests that the perspective instructions did not influence performance on the SVT/MIT tests and that the differences in performance on the relevant and irrelevant meaning change test sentences was a function of test item difficulty.

One possible reason why perspective instructions did not influence performance on the SVT/MIT tests is that the unit of analysis in the experiment was not sensitive enough to pick up the perspective effects. The unit of analysis in the experiment was performance on four test items. Given that chance performance was

two out of four correct, there was simply not very much possible variability in the dependent variable.

The remaining two significant effects in the analysis of Experiment 2 are uninteresting from the perspective of the storage/retrieval hypothesis. On the whole, subjects performed better on irrelevant test sentences than they did on relevant test sentences, and performance on meaning change sentences was better than it was on paraphrase test sentences.

### Experiment 3

The purpose of Experiments 3 and 4 was to provide a further test of the storage/retrieval hypothesis. Bonnie Meyer and her colleagues have shown that the hierarchical position of material in a passage (as revealed by her text analysis procedure) is predictive of a subject's ability to recall the material. However, hierarchical position is not predictive of a subject's ability to recognize material that had been read. The studies by Meyer and her colleagues provide the rationale for the third and fourth experiment.

The specific purpose of Experiment 3 was to determine if Meyer's recall results would replicate using the materials and conditions available in the LAMP facility. Subjects in Experiment 3 read a passage that contained material varying in hierarchical level. After they had read the passage they recalled everything they could remember from the passage. Meyer's results would be replicated if subjects recalled more of the material from high in

the text analysis hierarchy than they did material low in the text analysis hierarchy.

### Method

Materials, design, and subjects. All subjects in the experiment read a passage that had been developed for a study that had been previously conducted at the LAMP facility (Royer, Tirre, Greene & Sinatra, 1987). The passage, which was concerned with static electricity, was 32 sentences long, approximately 1000 words in length, and was excerpted from an Air Force Career Development course in basic electronics. The passage is reproduced in Appendix B of this report. The passage had been subjected to a Meyer text analysis and sentences within the passage were designated as being high or low in a hierarchy as a result of that analysis. There were 10 sentences classified as high and 10 that were classified as low. Eighty-seven Air Force enlistees read and recalled the passages.

Procedure. Subjects were seated at individual computer testing stations. All instructions and information were presented on the computer. Subjects were first given a general orientation to the system which included a keyboard exercise.

Then subjects were given the following instructions:

"The purpose of this study is to see what people remember from text presented on a computer. After reading the passage that will be presented below, you will be asked to remember what you have read. During the computer session you will read one paragraph of a



passage at a time and then, after you have read the entire passage, you will be asked to recall the passage."

Scoring. The passage was divided in 87 idea units. (See Appendix C.) These idea units roughly corresponded to propositions. Two raters independently scored each recall protocol. Reliability (calculated as percent agreement between the two raters) was 67%. All discrepancies were resolved to yield a final percent agreement of 100%.

### Results

The data was subjected to a one-way ANOVA in which high and low hierarchy level were levels of the independent variable and proportion of correctly recalled idea units was the dependent variable. This analysis indicated hierarchical level was significant,  $F(1,86) = 47.2$ ,  $p < .01$ . However, the direction of the effect was opposite to that expected. Subjects recalled more material from low in the hierarchy (proportion of idea units recalled = .153) than they did material that was high in the hierarchy (proportion of idea units recalled = .076).

### Discussion

Experiment 3 indicated that the materials and conditions in the present Experiment 3 did not produce the text hierarchy effect that Meyer has reported in a number of studies. There are several reasons why we might have failed to find the text hierarchy effect in the present study. First, an examination of the passage suggests that the specific examples explicating higher level

principles or abstractions (i.e., material that would be classified as low in the hierarchy) are more "concrete" than the higher level material they explicate. Moreover, the actual examples are ones that subjects may have encountered before. For example, the cloth and glass rod examples commonly occur in elementary and secondary textbooks and it could be that the passage merely served to activate previously learned material. The fact that overall level of learning in the passage was so low is consistent with this interpretation.

#### Experiment 4

Experiment 4 was designed to provide a direct test of the storage/retrieval hypothesis using the static electricity passage used in Experiment 3. Subjects read the passage and then took either an SVT or MIT test. The tests had been constructed such that half of the test sentences based on material high in the hierarchy were paraphrases and half were meaning changes. Likewise, half of the test sentences based on passage material low in the hierarchy were paraphrases and half were meaning changes. Support for the storage/retrieval hypothesis would be present if hierarchical position influenced performance on the meaning change sentences (i.e., subjects performed better on test sentences based on material high in the hierarchy), but did not influence performance on the paraphrase test sentences.

#### Method

Design and subjects. Three between subject variables and two within subject variables were manipulated in the experiment. The

first between subject variable was type of test. Subjects took either an SVT test or a MIT test. The second between subject variable was test version. In order to counter balance test item type and sentence being tested, two versions of each test were constructed. This allowed a sentence tested by a paraphrase test sentence on version one to be tested by a meaning change test sentence on version two. The third between subject variable was a confidence judgment manipulation. Half of the subjects taking each of the tests expressed their confidence in their decisions; the remaining half of the subjects recorded their decisions without confidence judgments. This variable was manipulated to evaluate the psychometric properties of the tests.

The first within subject variable was position in the Meyer hierarchy. Ten of the sentences in the static electricity passage were high in the hierarchy and ten were low in the hierarchy. The final within subject variable was test item type. Half of the passage sentences high and low in the hierarchy were tested with paraphrase test sentences and half were tested with meaning change test sentences. Thus, the complete design was a 2(SVT or MIT test) X 2(test version 1 or version 2) X 2(confidence judgement or no confidence judgement) X 2(high or low in Meyer hierarchy) X 2(paraphrase or meaning change test items) ANOVA design. Complete data was available for 325 subjects who were Air Force Enlistees stationed at Lackland Air Force Base. The number of subjects assigned to each of the eight between subject cells was 42, 32, 42, 42, 41, 42, 42, and 42.

Materials. The passage used in the experiment was the same as the passage used in Experiment 3. On the basis of the Meyer analysis, 10 of the sentences were designated as high in the hierarchy, 10 were designated as low in the hierarchy, and 12 were designated as medium in the hierarchy. The hierarchical position of sentences was distributed with reasonable evenness over the passage.

For the SVT test, five of the ten high sentences were randomly designated to be represented by paraphrase test items and five were designated to be represented by meaning change test items. In version 2 of the test those items represented in version 1 by paraphrases were represented by meaning changes and those items represented by meaning changes were represented by paraphrases. The 12 medium level sentences in the SVT test were represented by 6 originals and 6 distractors. The original and distractor sentences were the same in test version 1 and test version 2.

The SVT test served as a template for the development of the MIT test in the sense that those items represented by paraphrases in the SVT test were represented by paraphrases in the MIT test and those items represented by meaning changes in the SVT test were represented by meaning change paraphrases in the MIT test. The 12 medium sentences were represented by 6 paraphrases and 6 meaning change paraphrases in the MIT test. These test items were the same in both versions of the MIT test. As was the case with

the SVT test, there were two versions of the test providing counter balancing between passage sentence and test item type.

Procedure. Subjects were seated at individual computer testing stations. All instructions and information were presented on the computer. Subjects were first given a general orientation to the system which included a keyboard exercise.

Then subjects in all conditions were given the following instructions:

"The purpose of this study is to see what people remember from text presented on a computer. After reading the passage that will be presented below, you will be given a series of test sentences. Your task will be to judge whether the meaning of each test sentence is the same or difference from a sentence that you read in the passage. During the computer session you will read one paragraph of a passage at a time and then, after you have read the entire passage, you will receive test sentences one at a time."

A practice paragraph and four practice test sentences were then presented. Subjects in the SVT test conditions received SVT practice items, and subjects in the MIT conditions received MIT practice items. Subjects in the confidence judgement conditions were further instructed:

"After you have made a judgement about the meaning of a sentence, you will rate your confidence in that judgement. Your confidence rating will be made on a

five-point scale with the rating of 1 meaning that you are unsure of your judgement and a rating of 5 indicating that you are certain about your judgement."

The passage was presented one paragraph at a time and subjects read at their own pace. Reading times per paragraph were collected. Test sentences were presented one at a time. Responses, confidence ratings, and response times for each test sentence were also collected.

### Results

The means and standard deviations for the experiment are reported in Table 3. The means in the table are the number of correct test items out of five possible correct. The data in the table sums over test type and test version. A MANOVA conducted on the data revealed significant effects for test version,  $F(1,317)=3.96$ ,  $p<.05$ , Meyer hierarchical level,  $F(1,317)=18.59$ ,  $p<.01$ , test item type,  $F(1,317)=585.1$ ,  $p<.01$ , and for the interaction between hierarchical level and test item type,  $F(1,317)=69.3$ ,  $p<.01$ . The remaining effects in the analysis were not significant. Since test type was not a significant effect in the analysis and it did not contribute to any significant interactions, the data for SVT and MIT tests were combined in reporting the means in Table 3. Each of the significant effects will be described below.

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Insert Table 3 About Here

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For some unknown reason subjects performed better on test version 2 (mean = 3.3) than they did on test version 1 (mean = 3.16). Although significant, it can be seen from the means that the absolute differences in performance on the two test versions were relatively small.

The significant effect for Meyer hierarchical level was in the opposite direction to that expected, but was consistent with the results obtained in Experiment 3. Subjects responded more accurately to test sentences based on material low in the hierarchy (mean = 3.35) than they did to test sentences based on material high in the hierarchy (mean = 3.12).

The significant effect for test item was due to the fact that subjects performed much better on paraphrase test sentences (mean = 3.93) than they did on meaning change test sentences (mean = 2.54).

The significant interaction between hierarchical position and test item type was attributable to the fact that the difference between high and low sentences tested with meaning change test sentences (difference = .69) was larger than the difference between high and low sentences tested with paraphrase test sentences (difference = .23). With both paraphrase and meaning change sentences subjects performed better on test sentences based on sentences low in the hierarchy than they did on test items based on sentences high in the hierarchy.

## Discussion

The hypothesis in the study was that subjects would perform better on meaning change test sentences based on material from high in the hierarchy than they would on meaning change test sentences from material low in the hierarchy, and that subjects would not perform differently on paraphrase test sentences as a function of hierarchical position. This hypothesis was not supported. First, performance on the paraphrase test sentences did tend to be influenced by hierarchical position with performance being better on test sentences based on material from high in the hierarchy than on test sentences based on material from low in the hierarchy. Second, performance on the meaning change test sentences was in the opposite direction to that expected. Subjects performed better on meaning change test sentences based on material from low in the hierarchy than they did on test sentences based on material from high in the hierarchy. No explanation for this pattern of results is obvious.

## Psychometric Considerations

In addition to evaluating the storage/retrieval hypothesis, the present research effort examined two possible ways of improving the reliability of SVT tests. The first technique was the use of a new testing format called the Meaning Identification Technique (MIT). Unlike the SVT which contains four different test item types (originals, paraphrases, meaning changes, and distractors) the MIT contains only two test item types: paraphrases and meaning change paraphrases. A previous study



(Marchant, Royer, & Greene, in press) indicated that the MIT had superior reliability and validity relative to the SVT when used to predict future learning performance in college courses. The present research effort attempted to verify that outcome at the LAMP facility.

The second procedure for enhancing reliability that was examined was to ask subjects to indicate their confidence in each of their judgments as to whether a test sentence had the same or a different meaning than a passage sentence. The rationale underlying the use of confidence judgments is that they may provide a finer index of examinee competence than the standard procedure for responding to SVT tests. Two experiments will be reported in this section. The data for Experiment 5 was collected as part of the previously reported Experiment 2, and the data for Experiment 6 was collected as part of Experiment 4.

### Experiment 5

#### Method

The subjects in the experiment read the burglar/homebuyer passage used in Experiments 1 and 2 and then responded to one of two versions of either SVT or MIT tests. The process of generating the tests and the procedures for data collection are described in the method section for Experiment 2.

#### Results

The reliabilities for the Experiment were calculated in a number of ways. The first procedure entailed calculating coefficient alphas for each test type and test version, collapsing

over experimental treatment. The data for this procedure are summarized in Table 4. The table reports the number of subjects taking each test, and the means, standard deviations and coefficient alphas for each form of the test.

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Insert Table 4 About Here

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The second procedure entailed calculating coefficient alphas for each experimental group, collapsing over test type (MIT & SVT) and test version. The data for this procedure are reported in Table 5.

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Insert Table 5 About Here

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### Discussion

As can be seen in Table 4, when reliabilities were calculated on each of the tests after collapsing over experimental treatment, the reliabilities for each of the tests were very low and there was no evidence that MIT tests were more reliable than SVT tests. As a check on the calculation of the reliabilities the data from the experiment were re-analyzed using a split-half technique of estimating reliabilities and the results were very comparable to those reported in Table 4.

The reliabilities calculated separately by experimental treatment and collapsed over test type and test version (reported in Table 5) are considerably higher than those in Table 4. One

possible reason for this is that the first procedure (collapsing treatment conditions) contributes treatment variance to individual ability variance. That is, it is possible that treatment condition interacted with test items in some fashion to contribute nonsystematic variance to item performance. Thus, when treatment conditions were analyzed separately this nonsystematic variance was reduced and test reliability improved. One likely reason for the relatively low test reliabilities is that performance on the tests was high, thereby truncating score distributions. Previous research has found optimum reliabilities for SVT tests when mean performance is about 75% correct with a symmetrical spread of scores over the possible range. Overall performance in the present study was 80% correct and the scores were not symmetrically distributed over the entire range of possible scores. Figure 1 displays a frequency distribution of scores from the experiment, and as can be seen in the figure, the scores are strongly negatively skewed.

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Insert Figure 1, About Here

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Further evidence of the impact of the skewed distribution can be found in an SPSS-X output statistic called STANDARDIZED ITEM ALPHA (which is a coefficient alpha computed on standardized scores). The standardized reliabilities using the first procedure for calculating reliabilities (collapsing over treatment

condition) were: .35 for SVT version 1, .47 for SVT version 2, .47 for MIT version 1, and .44 for MIT version 2.

The truncated distributions could have also contributed to the failure to find superior reliability for the MIT tests relative to SVT tests. MIT tests could be expected to be more reliable in situations where performance on originals and distractors in an SVT test was high relative to performance on meaning changes and paraphrases. This would result in the bulk of the discriminatory power of the test being carried by the meaning change and paraphrase test items. This pattern of performance is not atypical in situations where test passages are chosen to bracket a subjects reading ability. MIT tests would be expected to be more reliable in this type of situation because the paraphrases and meaning change paraphrases provide even discriminatory power over all of the test items.

The conditions for showing an advantage of MIT items over SVT items are not present, however, in Experiment 5. As can be seen in Table 4, performance on all four of the test used in the Experiment was uniformly high.

### Experiment 6

#### Method

Subjects in the experiment read the static electricity passage and responded to an SVT or an MIT test. Half of the subjects taking the two types of tests also indicated their confidence in the judgement on a five point scale (1 = not at all confident I'm correct, 5 = very confident I'm correct). The

confidence rating was combined with accuracy of responding to create a new score for each test item. This was accomplished by multiplying a subject's confidence judgement by a 1 (item correct) or -1 (item wrong). Thus, scores on a given item could range from -5 (very confident but wrong) to +5 (very confident and correct) with no score of 0.

The procedure for developing the SVT and MIT tests and for conducting the experiment are described in the method section for Experiment 4.

### Results

As was the case in Experiment 5, a number of procedures were used to calculate test reliabilities. The first technique entailed calculating reliabilities separately by test type and test version. The means, standard deviations, number of subjects taking each test, and coefficient alphas derived from this procedure are reported in Table 6. The coefficient alphas using the same procedure for subjects providing confidence judgments are reported in Table 7.

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Insert Table 6 and 7 About Here

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The second procedure for calculating reliabilities entailed collapsing over test version. Test version was a significant source of variance, as reported in Experiment 4, and collapsing over test version could be expected to add systematic variance to subjects scores. The reliabilities using this procedure are

reported in Table 8. Table 8 also reports data using this procedure using confidence rating data.

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Insert Table 8 About Here

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### Discussion

Again, test reliabilities were very low when calculated separately on test type and test version, although they were somewhat higher than in Experiment 5. Moreover, there was no evidence that the reliability of MIT tests was higher than the reliability of SVT tests.

Calculating reliabilities collapsed over test version resulted in a considerable improvement in the coefficient alphas. Moreover, when the confidence judgment reliabilities were calculated after collapsing over test version there was only a marginal improvement in reliability relative to the calculation of reliabilities using raw scores, as shown in Table 8. The increase in reliability associated with collapsing over test version (which was a significant source of variance) is probably attributable to increasing the systematic variance in the test scores.

The reason for the very low reliabilities in Experiment 6 when calculated separately by test type and test version may again be associated with the spread of the scores. Overall correct performance on the tests was 66%, which is somewhat low for optimum test reliability. Moreover, the distribution of test scores was strongly peaked. Figure 2 provides a graphic display

of the score distribution in the study. As can be seen in the Figure, the bulk of the scores occur between the values of 17 and 25. As was the case in Experiment 5, the Standardized Item Alphas were considerably higher than the normal coefficient alphas when calculated separately by test type and test version. For the four tests the standardized alphas were: SVT version 1 = .71, SVT version 2 = .45, MIT version 1 = .51, and MIT version 2 = .47.

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Insert Figure 2 About Here

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As can be seen in Table 7, asking subjects to rate their confidence in their judgments enhances the reliabilities of the tests. One probable reason for the increase in reliabilities is because of the more advantageous distributional properties of the confidence/accuracy scores. Figure 3 presents a frequency distribution for the confidence/accuracy scores and as can be seen the scores are distributed relatively symmetrically over a broad range of score values. Another indication of the superior distributional properties of the confidence/accuracy score can be found in the standardized item alphas. Unlike previous analyses in which the standardized alphas were considerably higher than the normal alphas, there was little difference between the two statistics for the confidence/accuracy scores. For the four tests the values were: SVT version 1 = .66, SVT version 2 = .58, MIT version 1 = .30, MIT version 2 = .64.

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Insert Figure 3 About Here

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### General Discussion

The research conducted at the LAMP facility had two primary purposes: first, to determine if performance on paraphrase and meaning change SVT items could be used as indices of an examinee's ability to store and retrieve information that had been read, and second, to determine if two new procedures for constructing and administering SVT tests had superior psychometric properties relative to traditional SVT tests.

### Experimental Results

The results of the experiments reported in this document suggests that paraphrase and meaning change test sentences do not have the properties they were hypothesized to have. Previous research had suggested that paraphrase test sentences seemed to be sensitive to whether a subject had initially stored information read from text whereas meaning change test sentences seemed to be sensitive to whether subjects could retrieve information that had previously been stored. The pattern of results were not consistent with this interpretation. In both experiments performance on meaning change sentences did vary more as a function of experimental manipulations (as was predicted) than did performance on paraphrase test sentences; however, the variation was in a direction opposite to that predicted. In Experiment 2 subjects performed better on irrelevant meaning change test sentences than



they did on relevant meaning change test sentences, and in Experiment 4, subjects performed better on meaning change test sentences based on material low in the hierarchy than they did on meaning change test sentences based on material from high in the passage hierarchy.

The fact that in both experiments meaning change test sentences did show greater sensitivity to experimental manipulations designed to influence storage and retrieval processes than did paraphrase test sentences suggests that there are differences in the processes subjects use to respond to the test sentences. And it is possible that the manipulations designed to influence storage and retrieval processes did not operate in the manner they were envisioned to operate. For example, as described in the discussion section for Experiment 4, there is reason to believe that the material designated as low in the hierarchy by the Meyer analysis procedure is not, in fact, less retrievable than material high in the hierarchy. That is, subjects in Experiment 3 free recalled more low material than high material, and an inspection of the passage suggested reasons as to why low material might be more retrievable than high material. If this is the case, then the results of Experiment 4 are consistent with predictions. However, this interpretation would have to be reconciled with the results of Experiments 1 and 2, where the pattern of performance on meaning change test sentences was not consistent with the pattern of free recall performance.

In conclusion, there does appear to be something going on with respect to using meaning change and paraphrase test sentences as indices of individual differences in reading and learning ability, but the nature of what that something is will have to await a finer grained analysis of the present data set and/or future research.

### Psychometric Properties

The second purpose of the research effort was to try out a new version of SVT tests and a new procedure for taking the tests as a means of improving test reliability. The new version of the SVT is called the MIT, and in contrast to the four item types in SVT tests, MIT tests have only two item types (paraphrases and meaning change paraphrases).

The results from Experiments 5 and 6 suggest that MIT tests did not have superior reliability relative to SVT tests. This result cannot be taken as conclusive because of the restricted distributions of test scores obtained in both Experiments 5 and 6. It is still possible that the MIT procedure would have better reliability under conditions where examinees did not perform very well or very poorly on the tests.

The use of confidence ratings as a means of improving test reliability appears to be promising. The results from Experiment 6 in which reliabilities were calculated separately for test type and test version indicated there was a substantial improvement in test reliability when subjects provided their degree of confidence in each judgement regarding whether a test sentence meant the same

as a passage sentence. The results from subsequent analyses suggested that improved reliability associated with asking examinees to make confidence judgments is likely to occur only in situations where range of examinee scores is restricted. Thus, it might be an attractive procedure when examinees could be expected to perform either very well or very poorly on the tests.

#### General Comments on the Psychometric Properties of SVT Tests

The results of present and past research on SVT test suggests some general comments about the reliability of SVT tests. SVT tests have been used in a considerable number of studies using elementary school students as subjects. The general strategy in those studies has been to try to "bracket" the reading ability of the students with the test passages. That is, we have attempted to have one or more passages that are below that the presumed average reading ability of the examinees, one or more passages that are at average reading level, and one or more passages that are above average reading level. Tests designed in this fashion have had excellent reliability and validity.

In the present research this strategy was not followed in the sense that the passage used in Experiments 1 and 2 was probably below the reading level of the average examinee and the passage used in Experiments 3 and 4 may well have been above the average reading level of the examinees. The result was truncated distributions of performance and low test reliabilities as indicated by traditional measures of test reliability.

Traditional is emphasized in the previous sentence because the

tests could possibly have good reliabilities if one had a different purpose for administering the tests. Consider the possibility that the tests were going to be used in a criterion referenced fashion rather than a norm referenced fashion. That is, imagine that the static electricity passage was being used to select enlistees for admission to electronics school and that examinees scoring above a certain level would be admitted and those below that level would be rejected. Now consider that the index of reliability was consistency of classification rather than coefficient alpha. In this case the truncated distributions would not be a problem (as they are not with criterion referenced tests) and the reliability of the tests could be fine.

This line of thinking suggests that the development of optimum SVT tests should begin with a consideration of the purpose for administering the test. Tests designed to assess the general reading competence of examinees should be constructed from passages spanning a range of difficulty. Alternatively, if the tests are designed to determine if examinees can understand a particular content, as would be the case for the selection purpose mentioned above, tests should be constructed from the materials of interest.

The results of the present research do suggest though, that individual difference information can be obtained even from severely truncated distributions if subjects are asked to express their confidence in their responses to test sentences. This could prove to be a valuable technique in a variety of applications.

**Table 1****Means Proportion Recalled by Condition in Experiment 1**

Perspective Condition	Relevant	Irrelevant
Before	.284 <sup>a</sup> (.12) <sup>b</sup>	.197 (.12)
After	.292 (.10)	.053 (.06)
Control	.304 (.12)	.238 (.12)

<sup>a</sup>Mean<sup>b</sup>SD

**Table 2**

Mean Number Correct for Relevant and Irrelevant Material by Type of Item and Condition in Experiment 2

Perspective Condition	Relevant Paraphrase	MC	Irrelevant Paraphrase	MC
Before	2.85 <sup>a</sup> (.98) <sup>b</sup>	2.95 (.94)	2.86 (.93)	3.36 (.69)
After	2.95 (.85)	2.98 (.92)	2.98 (.88)	3.48 (.70)
Control	3.00 (.84)	3.16 (.76)	2.99 (.74)	3.32 (.78)

<sup>a</sup>Mean

<sup>b</sup>SD

Note: Total possible correct is 4.

Table 3

Mean Number Correct for High and Low Material by Type of Item in Experiment 4

High		Low	
Paraphrase	Meaning Change	Paraphrase	Meaning Change
4.05 <sup>a</sup> (.95) <sup>b</sup>	2.19 (1.0)	3.82 (1.1)	2.89 (1.2)

<sup>a</sup>Mean

<sup>b</sup>SD

Note: Total possible correct is 5.

Table 4

Mean Number Correct and Reliability Coefficients for Experiment 5

Test	N	Mean <sup>a</sup>	SD	Coefficient Alpha
SVT - V1	63	22.83	2.33	.0662
SVT - V2	49	22.71	2.59	.1108
MIT - V1	62	22.87	2.61	.1106
MIT - V2	55	21.36	2.71	.1122

<sup>a</sup>Number of Test Items = 28.



**Table 5**

Mean Number Correct and Reliability Coefficients for Treatment Groups for Experiment 5

Treatment	N	Mean <sup>a</sup>	SD	Coefficient Alpha
Perspective Before	65	22.09	2.70	.4238
Perspective After	82	22.65	2.45	.3461
Control	82	22.57	2.72	.4628

<sup>a</sup>Number of Test Items = 28.

**Table 6****Mean Number Correct and Reliability Coefficients for Experiment 6**

Test	N	Mean <sup>a</sup>	SD	Coefficient Alpha
SVT - V1	74	20.57	4.40	.3501
SVT - V2	84	21.32	3.33	.1579
MIT - V1	83	21.24	3.40	.1872
MIT - V2	84	21.45	3.28	.1626

<sup>a</sup>Number of Test Items = 28.

**Table 7****Reliability Coefficients - Confidence Rating Data<sup>a</sup>**

Test	Coefficient	N
SVT - Version 1	.6409	37
SVT - Version 2	.5300	34
MIT - Version 1	.2894	36
MIT - Version 2	.6437	35

<sup>a</sup>Number of Test Items = 32.

Table 8

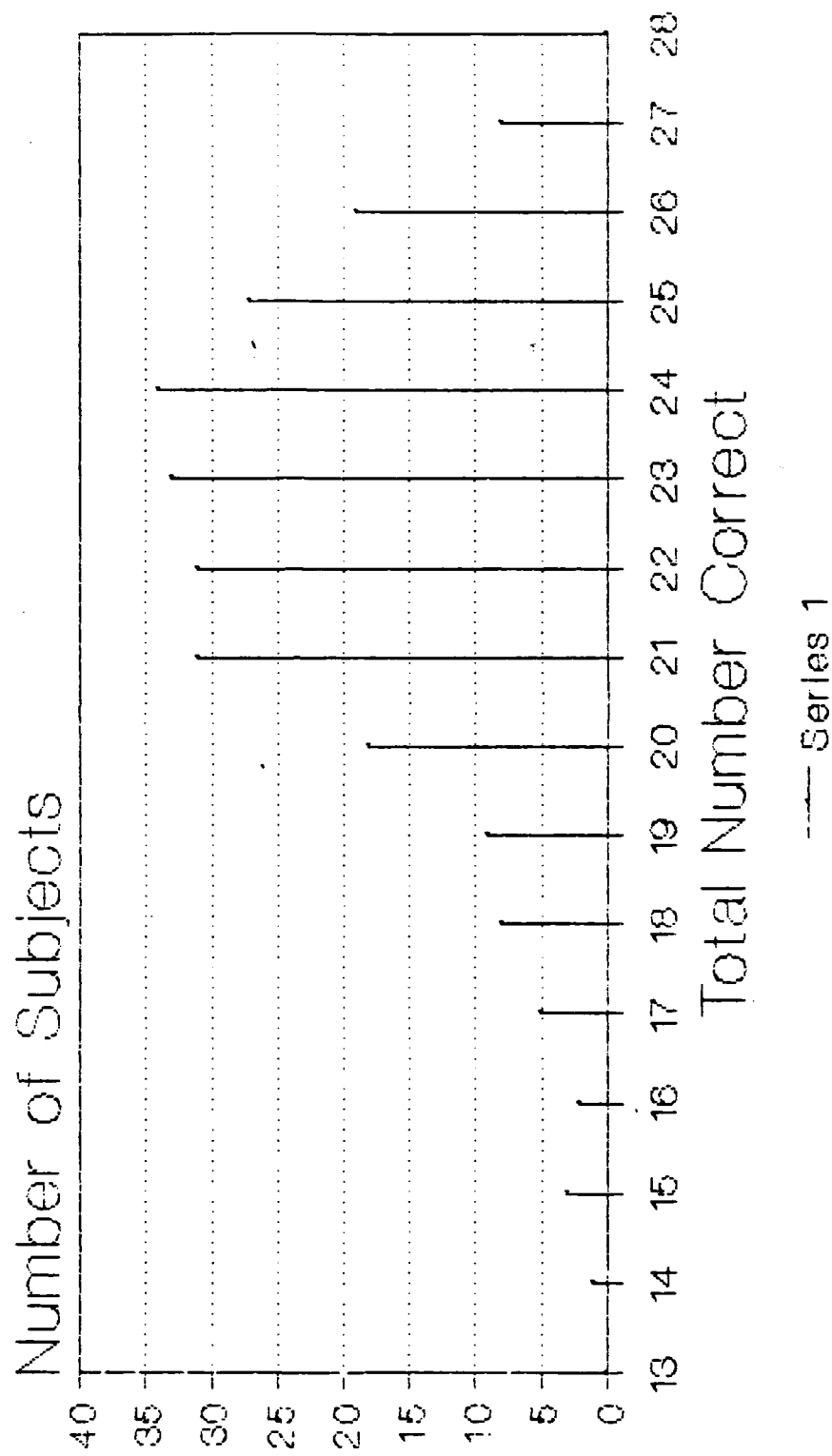
Mean Number Correct and Reliability Coefficients for Experiment 6

Test	N	Mean <sup>a</sup>	SD	Coefficient Alpha
No Confidence Ratings				
SVT	158	20.96	3.89	.5607
MIT	167	21.35	3.35	.4130
Confidence Ratings				
SVT	71			.5683
MIT	71			.4486

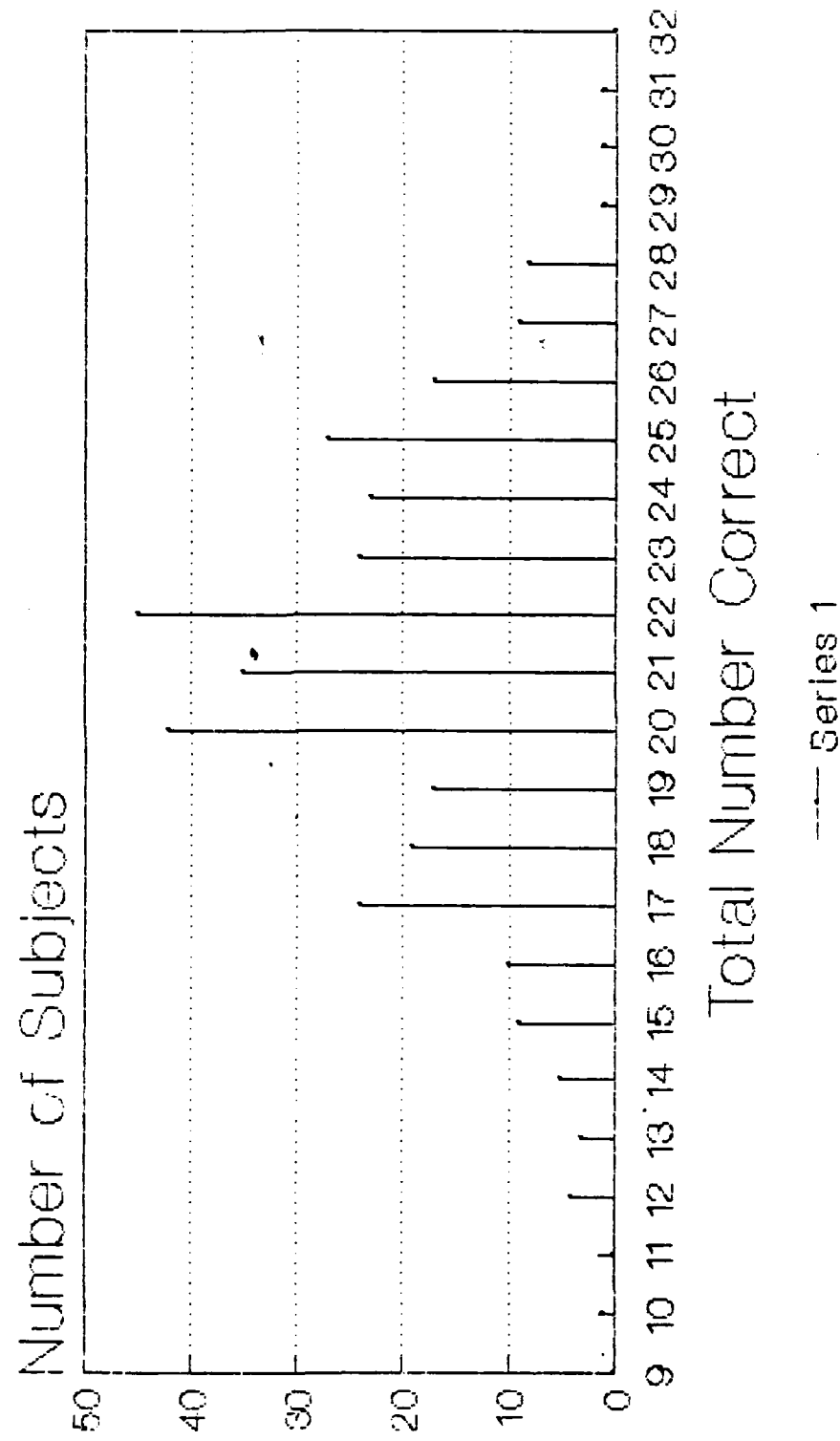
<sup>a</sup>Number of Test Items = 28.

Note: Means and standard deviations are not reported for confidence ratings because they are not meaningful.

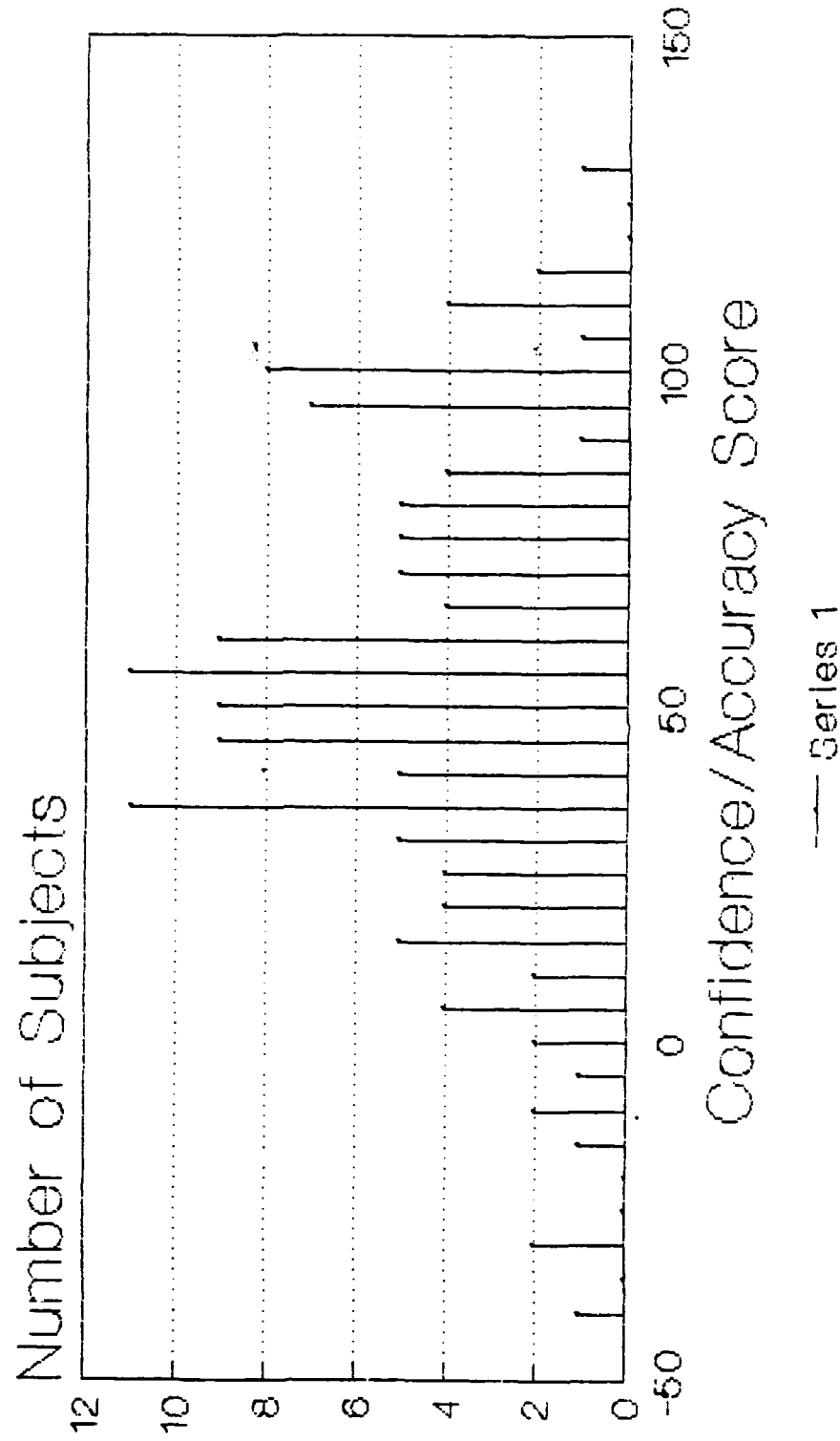
**Figure 1**  
**Frequency Distribution: Experiment 5**



**Figure 2**  
**Frequency Distribution: Experiment 6**



**Figure 3**  
**Frequency Distribution: Confidence Score**



X Values are Midpoints of Intervals

### References

- Anderson, R. C., & Pichert, J. W. (1978). Recall of previously unrecallable information following a shift in perspective. Journal of Verbal Learning and Verbal Behavior, 17, 1-12.
- Anderson, R. C., Pichert, J. W., & Shirey, L. L. (1983). Effects of the reader's schema at different points in time. Journal of Educational Psychology, 75, 271-279.
- Britton, B. K., Meyer, B. J. F., Hodge, M. N., & Glynn, S. M. (1980). Effects of the organization of text on memory: Tests of retrieval and response criterion hypotheses. Journal of Experimental Psychology: Human Learning and Performance, 6, 620-629.
- Kintsch, W. (1974). The representation of meaning in memory. Hillsdale, NJ: Erlbaum.
- Meyer, B. J. F. (1975). The organization of prose and its effect on memory. Amsterdam: North Holland Publishing Co.
- Pichert, J. W., & Anderson, R. C. (1977). Taking different perspectives on a story. Journal of Educational Psychology, 69, 309-315.
- Rasool, J. M., & Royer, J. M. (1986). Assessment of reading comprehension using the Sentence Verification Technique: Evidence from narrative and descriptive texts. Journal of Educational Research, 79, 180-184.
- Royer, J. M. (1986). The Sentence Verification Technique as a measure of comprehension: Validity, reliability, and practicality. Unpublished paper.



- Royer, J. M., & Hambleton, R. K. (1983). Normative study of 50 reading comprehension passages that use the Sentence Verification Technique. Unpublished study.
- Royer, J. M., Abranovic, W. A., & Sinatra, G. (in press). Using entering reading performance as a predictor of course performance in college classes. Journal of Educational Psychology.
- Royer, J. M., Hastings, C. N., & Hook, C. (1979). A sentence verification technique for measuring reading comprehension. Journal of Reading Behavior, 11, 355-363.
- Royer, J. M., Marchant, H., & Sawula, M. (1986). Can the sentence verification technique be used to measure both the storage and retrieval of text? Paper in development.
- Royer, J. M., Kulhavy, R. W., Lee, J. B., & Peterson, S. E. (in press). The sentence verification technique as a measure of listening and reading comprehension. Educational and Psychological Research.
- Royer, J. M., Lynch, D. J., Hambleton, R. K., & Bulgarelli, C. (1984). Using the sentence verification technique to assess the comprehension of technical text as a function of subject matter expertise. American Educational Research Journal, 21, 839-869.
- Royer, J. M., Marchant, H., Sinatra, G., & Lovejoy, D. (1985). Predicting college course performance by administering reading comprehension tests at the beginning of the semester: Evidence for general and specific factors. Paper

in preparation.

## Appendix A

## Passage, SVT, and MIT Items for Experiment 1 and 2 and 5

## Skipping School

The two boys ran until they came to the driveway. "See, I told you today was good for skipping choir practice," said Mark. "Mom is never home on Thursday," he added. "Besides, no one can tell we're here since the tall hedges hide the house from the road."

"I never knew your place was so big," said Pete, as the pair strolled across the finely-landscaped yard. "Yeah, and it's nicer now than it used to be since Dad had the new stone siding put on and added the fireplace." A permanent underground sprinkler system was in operation as they approached the house. The sprinkler had been installed to keep the lawn going when the weather turned dry.

Once they got to the house, Pete peered through the window of the side door which led to the two-car garage. The garage was empty except for three 10-speed bikes. Mark grinned as he opened the side door, explaining that it was always open in case his younger sisters got home earlier than their mother. As they entered, Pete noticed a sign on the door indicating that the family participated in a "neighborhood watch" program which had been organized with the police.

Since Pete wanted to see the house, Mark started with the living room which, like the rest of the downstairs, was newly painted. Mark and Pete's tour stopped for about 20 minutes as they listened to the new Twisted Sister album on the large, shiny stereo in the living room. The dining room, with all the china, silver, and cut glass, was no place to play, so the boys moved into the kitchen where they made sandwiches. Mark said they wouldn't go to the basement because it was damp and musty. "Dad says we'll have new plumbing installed by the end of next month."

"This is where my Dad keeps his famous paintings and his coin collection," Mark said as they peered into the den. Mark pointed out that the local art dealer was constantly asking Mark's Dad to sell the paintings, which were valued at about \$5000. Mark bragged that he could get spending money whenever he needed it since he'd discovered that his Dad kept a lot in the desk drawer. As Mark pulled open the drawer, Pete's eyes were drawn to the handgun laying on top of a bunch of papers.

There were three upstairs bedrooms. Pete noticed that the upper floor was not as new-looking as the downstairs. Mark showed Pete his mother's closet which was filled with furs and the locked box which held her jewels. Pete's attention was caught by the huge, glass sliding door which looked out over the backyard. His sisters' room was uninteresting except for the color TV which Mark carried to his room. Mark bragged that the bathroom in the hall was his since one had been added to his sisters room for their use. The big highlight in his room, though, was a leak in the ceiling where the old roof had finally rotted.

## SVT Test - Version 1

- |                |     |  |
|----------------|-----|--|
| PARAPHRASE     | 1.  | Mark smiled while opening the side door, stating that it was never locked because his younger sisters might come home before their mother.                                 |
| DISTRACTOR     | 2.  | Pete noticed that the time flew by as they enjoyed their day away from school.   |
| PARAPHRASE     | 3.  | As Pete was interested in a tour of the house, Mark began with the living room which, like all of the first floor rooms, had recently received a new coat of paint.        |
| ORIGINAL       | 4.  | "Yeah, and it's nicer now than it used to be since Dad had the new stone siding put on and added the fireplace."   |
| DISTRACTOR     | 5.  | Mark had a ham sandwich, while Pete had a peanut butter and jelly one.   |
| MEANING CHANGE | 6.  | "See, I told you choir practice would get out early today," said Mark.   |
| PARAPHRASE     | 7.  | "Mom is out all day on Thursday," Mark continued.  |
| DISTRACTOR     | 8.  | "It looks like your lawn is drowning with all that water," said Pete, as they walked up the hill.  |
| ORIGINAL       | 9.  | "Besides, no one can tell we're here since the tall hedges hide the house from the road."  |
| PARAPHRASE     | 10. | They had put in the sprinkler system to water the grass during the dry periods.  |
| DISTRACTOR     | 11. | The boys walked quietly up to the house so that the neighbors wouldn't notice their early return from school.  |
| MEANING CHANGE | 12. | As they entered, Pete noticed a sign on the door indicating that the family participated in a "neighborhood watch" program which the neighbors had organized on their own. |
| ORIGINAL       | 13. | Mark and Pete's tour stopped for about 20 minutes as they listened to the new Twisted Sister album on the large, shiny stereo in the living room.                          |

- MEANING CHANGE 14. The two boys ran around to the backyard.
- PARAPHRASE 15. "Here is the room where Dad stores his coin collection and his well-known paintings," said Mark as the two looked into the den.
- ORIGINAL 16. Pete's attention was caught by the huge, glass sliding door which looked out over the backyard.
- MEANING CHANGE 17. Mark showed Pete his grandmother's closet which was filled with furs and the locked box which held her jewels.
- DISTRACTOR 18. Mark's parents' bedroom was located at the end of the upstairs hallway.
- ORIGINAL 19. Mark said they wouldn't go to the basement because it was damp and musty.
- MEANING CHANGE 20. The dining room, with all the china, silver, and cut glass, was no place to play, so the boys moved into the den where they played a game.
- ORIGINAL 21. There were three upstairs bedrooms.
- PARAPHRASE 22. Mark proudly pointed out that the hall bathroom was his own because his sisters used the one that had been installed in their room.
- MEANING CHANGE 23. "Dad says we'll have new carpeting installed by the end of next month."
- PARAPHRASE 24. When Mark tugged open the drawer, Pete's attention was caught by the pistol resting on top of a pile of papers.
- MEANING CHANGE 25. The big highlight in Mark's sisters' room, though, was a leak in the ceiling where the old roof had finally rotted.
- PARAPHRASE 26. Pete thought that the first floor looked newer than the second floor.
- MEANING CHANGE 27. Mark bragged that he could get spending money whenever he needed it since he'd discovered that his Mom kept a lot in the kitchen drawer.
- DISTRACTOR 28. From the glass door, Pete could see that the lawn had just been mowed.

## SVT Test - Version 2

- |                |     |  |
|----------------|-----|--|
| MEANING CHANGE | 1.  | Mark grinned as he opened the side door, explaining that it was always open in case his younger sisters got home earlier than he did.  |
| DISTRACTOR     | 2.  | Pete noticed that the time flew by as they enjoyed their day away from school.   |
| MEANING CHANGE | 3.  | Since Pete wanted to see the house, Mark started with the living room which, like the rest of the downstairs, needed to be painted.  |
| ORIGINAL       | 4.  | "Yeah, and it's nicer now than it used to be since Dad had the new stone siding put on and added the fireplace."   |
| DISTRACTOR     | 5.  | Mark had a ham sandwich, while Pete had a peanut butter and jelly one.   |
| PARAPHRASE     | 6.  | "See, I told you choir practice would get out early today," said Mark.   |
| MEANING CHANGE | 7.  | "Mom is never home on Tuesday," he added.  |
| DISTRACTOR     | 8.  | "It looks like your lawn is drowning with all that water," said Pete, as they walked up the hill.  |
| ORIGINAL       | 9.  | "Besides, no one can tell we're here since the tall hedges hide the house from the road."  |
| MEANING CHANGE | 10. | The sprinkler had been installed to keep the flower garden going when the weather turned dry.  |
| DISTRACTOR     | 11. | The boys walked quietly up to the house so that the neighbors wouldn't notice their early return from school.  |
| PARAPHRASE     | 12. | When they came in, Pete saw a notice on the door that said that the household had taken part in a "neighborhood watch" program that the neighborhood had arranged with the police. |
| ORIGINAL       | 13. | Mark and Pete's tour stopped for about 20 minutes as they listened to the new Twisted Sister album on the large, shiny stereo in the living room.                                  |
| PARAPHRASE     | 14. | Both boys ran up to the driveway.  |

- MEANING CHANGE 15. "This is where my Dad keeps his famous paintings and his coin collection," Mark said as they peered into his parents' bedroom.
- ORIGINAL 16. Pete's attention was caught by the huge, glass sliding door which looked out over the backyard.
- PARAPHRASE 17. Mark pointed out his mother's closet to Pete which contained her furs and jewels in a locked box.
- DISTRACTOR 18. Mark's parents' bedroom was located at the end of the upstairs hallway.
- ORIGINAL 19. Mark said they wouldn't go to the basement because it was damp and musty.
- PARAPHRASE 20. The dining room wasn't a good place to play because of all the china, silver, and cut glass, so Mark and Pete went to make sandwiches in the kitchen.
- ORIGINAL 21. There were three upstairs bedrooms.
- MEANING CHANGE 22. Mark bragged that the bathroom in the hall was his since one had been added to his parents' room for their use.
- PARAPHRASE 23. "My Dad said that the new plumbing will be put in before next month is out."
- MEANING CHANGE 24. As Mark pulled open the drawer, Pete's eyes were drawn to the handgun laying on top of a pile of clothes.
- PARAPHRASE 25. What was most interesting in Mark's room, however, was the leaky ceiling resulting from the old rotting roof.
- MEANING CHANGE 26. Pete noticed that the downstairs was not as new-looking as the upper floor.
- PARAPHRASE 27. Mark boasted that he was able to get extra cash as needed since he had found that his Dad kept lots of cash in the drawer in the desk.
- DISTRACTOR 28. From the glass door, Pete could see that the lawn had just been mowed.

## MIT Test - Version 1

- |               |     |  |
|---------------|-----|--|
| PARAPHRASE    | 1.  | Mark smiled while opening the side door, stating that it was never locked because his younger sisters might come home before their mother.                                   |
| PARAPHRASE    | 2.  | As they came toward the house, a permanent underground sprinkler system was operating.   |
| PARAPHRASE    | 3.  | As Pete was interested in a tour of the house, Mark began with the living room which, like all of the first floor rooms, had recently received a new coat of paint.          |
| MC-PARAPHRASE | 4.  | "Yes, and the house is even nicer now with the completion of the new stone siding and the pool that my Dad had added."   |
| MC-PARAPHRASE | 5.  | "I wasn't aware that your house was so new," Pete said, as they both walked across the well-groomed yard.  |
| MC-PARAPHRASE | 6.  | "See, I said it would be a good day to skip band practice," Mark said.   |
| PARAPHRASE    | 7.  | "Mom is out all day on Thursday," Mark continued.  |
| MC-PARAPHRASE | 8.  | When they reached the house, Pete looked into the den through the side door window.  |
| PARAPHRASE    | 9.  | "Anyway, nobody can see that we're here because the hedges are so tall they block the house from the street."  |
| PARAPHRASE    | 10. | They had put in the sprinkler system to water the grass during the dry periods.  |
| MC-PARAPHRASE | 11. | The only things in the yard were three 10-speed bikes.   |
| MC-PARAPHRASE | 12. | When they went in, Pete saw a notice on the door that said that the household had taken part in a "neighborhood watch" program that the neighbors had arranged on their own. |
| PARAPHRASE    | 13. | The boys' tour came to a halt for around 20 minutes while they listened to the recent Twisted Sister record played on the big, shiny living room stereo.                     |



- MC-PARAPHRASE 14. Both boys ran around to the backyard.
- PARAPHRASE 15. "Here is the room where Dad stores his coin collection and his well-known paintings," said Mark as the two looked into the den.
- PARAPHRASE 16. The large, sliding glass door overlooking the backyard caught Pete's eye.
- MC-PARAPHRASE 17. Mark pointed out his grandmother's closet to Pete which contained her furs and jewels in a locked box.
- MC-PARAPHRASE 18. Mark's parents' room contained nothing interesting other than the color TV that Mark brought into his room.
- PARAPHRASE 19. Mark said they would stay out of the basement as it was damp and musty.
- MC-PARAPHRASE 20. The dining room wasn't a good place to play because of all the china, silver, and cut glass, so Mark and Pete went to the den to play a game.
- MC-PARAPHRASE 21. Upstairs there were three bookcases.
- PARAPHRASE 22. Mark proudly pointed out that the hall bathroom was his own because his sisters used the one that had been installed in their room.
- MC-PARAPHRASE 23. "My Dad said that the new carpeting will be put in before next month is out."
- PARAPHRASE 24. When Mark tugged open the drawer, Pete's attention was caught by the pistol resting on top of a pile of papers.
- MC-PARAPHRASE 25. What was most interesting in Mark's sisters' room, however, was the leaky ceiling resulting from the old rotting roof.
- PARAPHRASE 26. Pete thought that the first floor looked newer than the second floor.
- MC-PARAPHRASE 27. Mark boasted that he was able to get extra cash as needed since he had found that his Mom kept lots of cash in the drawer in the kitchen.
- PARAPHRASE 28. Mark mentioned that an art dealer from the

area was always after Mark's Dad to sell his paintings which were worth about \$5000.

## MIT Test - Version 2

- MC-PARAPHRASE 1. Mark smiled while opening the side door, stating that it was never locked because his younger sisters might come home before him.
- MC-PARAPHRASE 2. As they walked around the garden, a permanent underground sprinkler system was operating.
- MC-PARAPHRASE 3. As Pete was interested in a tour of the house, Mark began with the living room which, like all of the first floor rooms, was in need of a new coat of paint.
- PARAPHRASE 4. "Yes, and the house is even nicer now with the completion of the new stone siding and the fireplace that my Dad had added."
- PARAPHRASE 5. "I wasn't aware that your house was so big," Pete said, as they both walked across the well-groomed yard.
- PARAPHRASE 6. "See, I said it would be a good day to skip choir practice," Mark said.
- MC-PARAPHRASE 7. "Mom is out all day on Tuesday," Mark continued.
- PARAPHRASE 8. When they reached the house, Pete looked into the two-car garage through the side door window.
- MC-PARAPHRASE 9. "Anyway, nobody can see that we're here because the stone wall is so tall it blocks the house from the street."
- MC-PARAPHRASE 10. They had put in the sprinkler system to water the flower garden during the dry periods.
- PARAPHRASE 11. The only things in the garage were three 10-speed bikes.
- PARAPHRASE 12. When they went in, Pete saw a notice on the door that said that the household had taken part in a "neighborhood watch" program that the neighborhood had arranged with the police.
- MC-PARAPHRASE 13. The boys' tour came to a halt for around 20 minutes while they listened to the recent Twisted Sister record played on the big, shiny stereo in Mark's room.

- PARAPHRASE 14. Both boys ran up to the driveway.
- MC-PARAPHRASE 15. "Here is the room where Dad stores his coin collection and his well-known paintings," said Mark as the two looked into his parents' bedroom.
- MC-PARAPHRASE 16. The large, sliding glass door overlooking the pool caught Pete's eye.
- PARAPHRASE 17. Mark pointed out his mother's closet to Pete which contained her furs and jewels in a locked box.
- PARAPHRASE 18. Mark's sisters' room contained nothing interesting other than the color TV that Mark brought into his room.
- MC-PARAPHRASE 19. Mark said they would stay out of the attic as it was cold and musty.
- PARAPHRASE 20. The dining room wasn't a good place to play because of all the china, silver, and cut glass, so Mark and Pete went to make sandwiches in the kitchen.
- PARAPHRASE 21. Upstairs there were three bedrooms.
- MC-PARAPHRASE 22. Mark proudly pointed out that the hall bathroom was his own because his parents used the one that had been installed in their room.
- PARAPHRASE 23. "My Dad said that the new plumbing will be put in before next month is out."
- MC-PARAPHRASE 24. When Mark tugged the drawer open, Pete's attention was caught by the pistol resting on top of a pile of clothes.
- PARAPHRASE 25. What was most interesting in Mark's room, however, was the leaky ceiling resulting from the old rotting roof.
- MC-PARAPHRASE 26. Pete thought that the second floor looked newer than the first floor.
- PARAPHRASE 27. Mark boasted that he was able to get extra cash as needed since he had found that his Dad kept lots of cash in the drawer in the desk.

MC-PARAPHRASE 28. Mark mentioned that a coin dealer from the area was always after Mark's Dad to sell his coin collection which was worth about \$5000.

## Appendix B

## Passage, SVT, and MIT Items for Experiments 3,4 and 6

## STATIC ELECTRICITY / CHARGED BODIES

The fact that a comb, when rubbed with a cloth or run through your hair, will attract light pieces of paper has been known for a long time. The early Greeks were familiar with this phenomenon and, without knowing it, discovered the type of electricity that today is known as static electricity. The Greeks knew that when they rubbed a piece of amber, which they called elektron, with a piece of cloth, it would attract other objects such as bits of cloth or pith. From the Greek word for amber are derived the English words electron and electricity.

Originally, static electricity was considered electricity at rest, as the name static implies. Since electrons are continually in motion within the atom; static electricity is now more commonly associated with charged bodies.

An electrically charged body is one that has more or less than the normal number of electrons. It may be positively or negatively charged. A positively charged body is one in which some of the electrons have been removed from the atoms so that there is a deficiency of electrons; that is, there are fewer electrons than protons. A negatively charged body is one in which there is more than the normal number of electrons in each atom; that is, there are more electrons than protons. A body in which there is an equal number of electrons and protons in each atom is an uncharged or neutral body.

Removing electrons from a body involves physically attaching them to another body and then moving the other body some distance away. The second body will have an excess of electrons, and thus, will be negatively charged. The first body will have a deficiency of electrons, and thus, will be positively charged. This can be illustrated by rubbing glass with silk and then separating the two. Some of the electrons are rubbed off the glass onto the silk. This leaves the glass with a positive charge (deficiency of electrons) and the silk with a negative charge (excess of electrons). If the two bodies, the silk and the glass, are not brought into contact, they will retain the charges for a long period of time; the charges will eventually leak off to surrounding objects. When the silk and the glass are allowed to touch, however, the surplus of electrons on the silk move onto the glass and neutralize the charges on the two bodies.

When a rubber rod is briskly rubbed with a piece of woollen cloth, a number of electrons from the cloth adhere to the rubber rod. If the two objects are separated immediately, there will be an excess of electrons on the rubber rod. In other words, the rubber rod will be negatively charged. Note that a glass rod rubbed with wool has a negative charge.

A simple experiment can be performed to show the effects of these two different charges. Suppose that two small balls of pith

or any light material are suspended by a thread so that they hang freely. If both balls are touched with the negatively charged rubber rod, they will become negatively charged and will swing away from each other. If both balls are touched with the positively charged glass rod, the same thing will happen. In other words, when both pith balls have been charged the same way, they will repel each other. If one ball is touched with the positively charged glass rod and the other with the negatively charged rubber rod, they will have unlike charges and will swing toward each other. In other words, when the two balls have unlike charges, they will attract each other. This attraction shows that a force is present and that a field of force has been established. The field may be called an electrical field, a dielectric field, or an electrostatic field.

## SVT Test - Version 1

- PARAPHRASE 1. Now, static electricity is commonly linked with charged bodies because electrons inside atoms are constantly moving.
- MEANING CHANGE 2. Recently, static electricity has been considered electricity at rest, as the name static implies.
- PARAPHRASE 3. A body is negatively charged when there is an increase in the usual number of electrons in each atom; that is, electrons outnumber protons.
- MEANING CHANGE 4. The Greeks knew that when they rubbed a piece of amber, which they called "elektron," with a piece of cloth, it would repel other objects such as bits of cloth or pith.
- PARAPHRASE 5. A charged body may hold a positive or negative charge.
- ORIGINAL 6. The early Greeks were familiar with this phenomenon and, without knowing it, discovered the type of electricity that today is known as static electricity.
- MEANING CHANGE 7. A negatively charged body is one in which some of the electrons have been removed from the atoms so that there is a deficiency of electrons; that is, there are fewer electrons than protons.
- PARAPHRASE 8. The phenomenon of a comb attracting light fragments of paper, when it has been used on your hair or rubbed with a cloth, has been recognized for quite awhile.
- MEANING CHANGE 9. The second body will have an excess of electrons, and thus, will be positively charged.
- ORIGINAL 10. Some of the electrons are rubbed off the glass onto the silk.
- MEANING CHANGE 11. An electrically static body is one that has more or less than the normal number of electrons.
- PARAPHRASE 12. Detaching electrons from a body requires the physical attachment of the electrons onto a



- different body, then moving that body a considerable distance away.
- DISTRACTOR 13. For ionization to take place, there must be a transfer of energy in the atom.
- PARAPHRASE 14. We get the English words electricity and electron from the Greek word for amber.
- MEANING CHANGE 15. A body in which there is an equal number of electrons and protons in each atom is a stabilized or neutral body.
- PARAPHRASE 16. The body losing the electrons will be positively charged, since it is left with an insufficient number of electrons.
- DISTRACTOR 17. To understand how electrons become free of one body, it is necessary to understand energy levels within the atom.
- ORIGINAL 18. If the two bodies, the silk and the glass, are not brought into contact, they will retain the charges for a long period of time; the charges will eventually leak off to surrounding objects.
- MEANING CHANGE 19. If both balls are touched with the negatively charged rubber rod, they will become negatively charged and will swing toward each other.
- DISTRACTOR 20. The valence of an atom determines its ability to gain or lose an electron, which in turn determines the electrical properties of the atom.
- PARAPHRASE 21. The same effect is achieved when the positively charged glass rod touches the two balls.
- DISTRACTOR 22. Atoms that assume a charge are called ions.
- PARAPHRASE 23. Imagine that two little balls of pith, or any non-heavy substance, are hung by a string in such a way that they dangle freely.
- MEANING CHANGE 24. In other words, when the two rubber rods have unlike charges, they will attract each other.
- ORIGINAL 25. When a rubber rod is briskly rubbed with a

piece of woolen cloth, a number of electrons from the cloth adhere to the rubber rod.

- |                |     |  |
|----------------|-----|--|
| DISTRACTOR     | 26. | Electrons that are relatively free to move are know as conduction electrons.   |
| PARAPHRASE     | 27. | If the positively charged glass rod touches one ball and the negatively charged rubber rod touches the other ball, the balls will have different charges and will swing toward each other. |
| MEANING CHANGE | 28. | When the silk and the glass are allowed to touch, however, the surplus of electrons on the silk move onto the glass and the charges on the two bodies become positive.                     |
| ORIGINAL       | 29. | In other words, the rubber rod will be negatively charged.   |
| DISTRACTOR     | 30. | This force usually varies from point to point in the field, both in intensity and direction.   |
| ORIGINAL       | 31. | The field may be called an electrical field, a dielectric field, or an electrostatic field.  |
| MEANING CHANGE | 32. | In other words, when both rubber balls have been charged the same way, they will repel each other.   |

## SVT Test - Version 2

- MEANING CHANGE 1. Since protons are continually in motion within the atom; static electricity is now more commonly associated with charged bodies.
- PARAPHRASE 2. Static electricity was first thought to be electricity at rest, which can be inferred by the name static.
- MEANING CHANGE 3. A positively charged body is one in which there is more than the normal number of electrons in each atom; that is, there are more electrons than protons.
- PARAPHRASE 4. The Greeks were aware that when they stroked a bit of amber, which they named "elektron," with some fabric, it would draw to it other items such as fragments of pith or fabric.
- MEANING CHANGE 5. A glass rod may be positively or negatively charged.
- DISTRACTOR 6. While the early Greeks had detected the phenomenon of static electricity, they generally assumed that a soul or spirit inside the object caused the attraction.
- PARAPHRASE 7. A body is positively charged when some of the electrons have been taken away from the atoms so that there is an insufficient number of electrons; that is, there are more protons than electrons.
- MEANING CHANGE 8. The fact that a comb, when rubbed with a cloth or run through your hair, will repel light pieces of paper has been known for a long time.
- PARAPHRASE 9. The other body will have extra electrons, and therefore, will have a negative charge.
- DISTRACTOR 10. The electrons that orbit around the nucleus do not travel in a random way.
- PARAPHRASE 11. A body which holds either more or less than the usual number of electrons is an electrically charged body.
- MEANING CHANGE 12. Removing protons from a body involves physically attaching them to another body and then moving the other body some distance away.

- ORIGINAL 13. This can be illustrated by rubbing glass with silk and then separating the two.
- MEANING CHANGE 14. From the Greek word for attract are derived the English words electron and electricity.
- PARAPHRASE 15. A neutral or uncharged body is one that contains the same number of electrons and protons in each atom.
- MEANING CHANGE 16. The amber will have a deficiency of electrons, and thus, will be positively charged.
- ORIGINAL 17. If the two objects are separated immediately, there will be an excess of electrons on the rubber rod.
- DISTRACTOR 18. The positively charged body may attract the free electrons from atoms in its vicinity; these atoms, in turn, will attract electrons from adjacent atoms.
- PARAPHRASE 19. If both balls are touched with the negatively charged rubber rod, they will become negatively charged and will swing toward each other.
- ORIGINAL 20. This leaves the glass with a positive charge (deficiency of electrons) and the silk with a negative charge (excess of electrons).
- MEANING CHANGE 21. If both balls are touched with the positively charged glass rod, something different will happen.
- ORIGINAL 22. Note that a glass rod rubbed with wool has a negative charge.
- MEANING CHANGE 23. Suppose that two balls of pith, or any light material, are suspended by a thread so that they are touching.
- PARAPHRASE 24. That is, the two balls will swing toward each other if they have different charges.
- DISTRACTOR 25. When a rubber rod is briskly rubbed with a piece of woolen cloth, a number of electrons from the cloth adhere to the rubber rod.
- ORIGINAL 26. A simple experiment can be performed to show the effects of these two different charges.

- MEANING CHANGE 27. If one ball is touched with the positively charged glass rod and the other with the negatively charged rubber rod, they will become neutralized and they will not move.
- PARAPHRASE 28. If the two bodies come into contact, though, the charges on the silk and on the glass are neutralized, as the silk's excess electrons transfer to the glass.
- DISTRACTOR 29. This movement is from the negative toward the positive body.
- ORIGINAL 30. This attraction shows that a force is present and that a field of force has been established.
- DISTRACTOR 31. The arrangement of certain electrons determines the chemical properties of the atom.
- PARAPHRASE 32. That is, the two pith balls will repel each other when they have the same charge.

## MIT Test - Version 1

- |               |     |  |
|---------------|-----|--|
| PARAPHRASE    | 1.  | Now, static electricity is commonly linked with charged bodies because electrons inside atoms are constantly moving.   |
| MC-PARAPHRASE | 2.  | Static electricity is now thought to be electricity at rest, which can be inferred by the name static.   |
| PARAPHRASE    | 3.  | A body is negatively charged when there is an increase in the usual number of electrons in each atom; that is, electrons outnumber protons.                    |
| MC-PARAPHRASE | 4.  | We get the English words electricity and electron from the Greek word for attract.   |
| PARAPHRASE    | 5.  | A charged body may hold a positive or negative charge.   |
| PARAPHRASE    | 6.  | This fact was known by the early Greeks, who without being aware of it, detected the form of electricity that is now called static electricity.                |
| MC-PARAPHRASE | 7.  | A body which holds either more or less than the usual number of electrons is an electrically static body.  |
| PARAPHRASE    | 8.  | The phenomenon of a comb attracting light fragments of paper, when it has been used on your hair or rubbed with a cloth, has been recognized for quite awhile. |
| MC-PARAPHRASE | 9.  | The other body will now have extra electrons, and therefore, will have a positive charge.  |
| PARAPHRASE    | 10. | A number of the electrons, when rubbed off the glass, become attached to the silk.   |
| MC-PARAPHRASE | 11. | A body which holds either more or less than the usual number of electrons is an electrically static body.  |
| PARAPHRASE    | 12. | Detaching electrons from a body requires the physical attachment of the electrons onto a different body, then moving that body a considerable distance away.   |

- MC-PARAPHRASE 13. Rubbing silk on glass and then moving the two objects apart will eliminate this effect.
- PARAPHRASE 14. We get the English words electricity and electron from the Greek word for amber.
- MC-PARAPHRASE 15. A neutral or stabilized body is one that contains the same number of electrons and protons in each atom.
- PARAPHRASE 16. The body losing the electrons will be positively charged, since it is left with an insufficient number of electrons.
- MC-PARAPHRASE 17. If the two bodies are pulled apart promptly, the rubber rod will be left with no charge.
- PARAPHRASE 18. The silk and the glass will hold the charges for a considerable amount of time if the two materials are kept apart; at some point, the charges will escape to nearby bodies.
- MC-PARAPHRASE 19. If the negatively charged rubber rod touches both balls, they will take on a negative charge and will drift toward each other.
- MC-PARAPHRASE 20. The glass is left with a negative charge (an insufficient number of electrons) while the silk has a positive charge (extra electrons).
- PARAPHRASE 21. The same effect is achieved when the positively charged glass rod touches the two balls.
- MC-PARAPHRASE 22. Notice that a glass rod is neutralized when rubbed with wool.
- PARAPHRASE 23. Imagine that two little balls of pith, or any non-heavy substance, are hung by a string in such a way that they dangle freely.
- MC-PARAPHRASE 24. That is, the two rubber rods will swing toward each other if they have different charges.
- PARAPHRASE 25. If a fragment of woolen fabric is quickly rubbed over a rubber rod, some of the electrons from the fabric cling to the rubber rod.
- MC-PARAPHRASE 26. A basic experiment can be conducted to demonstrate the effects of these two similar charges.

- PARAPHRASE      27.    If the positively charged glass rod touches one ball and the negatively charged rubber rod touches the other ball, the balls will have different charges and will swing toward each other.
- MC-PARAPHRASE   28.    If the two bodies come into contact, though, the charges on the silk and on the glass become positive, as the silk's excess electrons transfer to the glass.
- PARAPHRASE      29.    That is, the rubber rod takes on a negative charge.
- MC-PARAPHRASE   30.    This pulling toward each other demonstrates that there is no longer a force present and that a field of force has been eliminated.
- PARAPHRASE      31.    The field of force may be referred to as an electrostatic field, an electric field, or a dielectric field.
- MC-PARAPHRASE   32.    That is, the two rubber balls will repel each other when they have the same charge.



## MIT Test - Version 2

- MC-PARAPHRASE 1. Now, static electricity is commonly linked with charged bodies because protons inside atoms are continually moving.
- PARAPHRASE 2. Static electricity was first thought to be electricity at rest, which can be inferred by the name static.
- MC-PARAPHRASE 3. A body is positively charged when there is an increase in the usual number of electrons in each atom; that is, electrons outnumber protons.
- PARAPHRASE 4. The Greeks were aware that when they stroked a bit of amber, which they named "elektron," with some fabric, it would draw to it other items such as fragments of pith or fabric.
- MC-PARAPHRASE 5. A glass rod may hold a positive or negative charge.
- MC-PARAPHRASE 6. This fact was known by the early Greeks, who without being aware of it, detected the form of electricity that is now called atomic electricity.
- PARAPHRASE 7. A body is positively charged when some of the electrons have been taken away from the atoms so that there is an insufficient number of electrons; that is, there are more protons than electrons.
- MC-PARAPHRASE 8. The phenomenon of a comb repelling light fragments of paper, when it has been used on your hair or rubbed with a cloth, has been recognized for quite awhile.
- PARAPHRASE 9. The other body will have extra electrons, and therefore, will have a negative charge.
- MC-PARAPHRASE 10. A number of the protons, when rubbed off the glass, become attached to the silk.
- PARAPHRASE 11. A body which holds either more or less than the usual number of electrons is an electrically charged body.
- MC-PARAPHRASE 12. Detaching protons from a body requires the physical attachment of the protons onto a

different body, then moving that body a considerable distance away.

- |               |     |   |
|---------------|-----|---|
| PARAPHRASE    | 13. | Rubbing silk on glass and then moving the two objects apart will demonstrate this effect.   |
| MC-PARAPHRASE | 14. | We get the English words electricity and electron from the Greek word for amber.  |
| PARAPHRASE    | 15. | A neutral or uncharged body is one that contains the same number of electrons and protons in each atom.   |
| MC-PARAPHRASE | 16. | The body losing the electrons will be positively charged, since it is left with an insufficient number of electrons.  |
| PARAPHRASE    | 17. | If the two bodies are pulled apart promptly, the rubber rod will be left with extra electrons.  |
| MC-PARAPHRASE | 18. | The silk and the glass will hold the charges for a considerable amount of time if the two materials are kept together; at some point, the charges will escape to nearby bodies. |
| PARAPHRASE    | 19. | If both balls are touched with the negatively charged rubber rod, they will become negatively charged and will swing toward each other.   |
| PARAPHRASE    | 20. | The glass is left with a positive charge (an insufficient number of electrons) while the silk has a negative charge (extra electrons).  |
| MC-PARAPHRASE | 21. | A different effect is achieved when the positively charged glass rod touches the two balls.   |
| PARAPHRASE    | 22. | Notice that a glass rod is negatively charged when rubbed with wool.  |
| MC-PARAPHRASE | 23. | Imagine that two little balls of pith, or any non-heavy substance, are hung by a string in such a way that they are touching.   |
| PARAPHRASE    | 24. | That is, the two balls will swing toward each other if they have different charges.   |
| MC-PARAPHRASE | 25. | If a fragment of woolen fabric is quickly rubbed over a metal rod, some of the electrons from the fabric cling to the metal rod.  |

- PARAPHRASE      26.    A basic experiment can be conducted to demonstrate the effects of these two distinct charges.
- MC-PARAPHRASE   27.    If the positively charged glass rod touches one ball and the negatively charged rubber rod touches the other ball, the balls will become neutralized and they will not move.
- PARAPHRASE      28.    If the two bodies come into contact, though, the charges on the silk and on the glass are neutralized, as the silk's excess electrons transfer to the glass.
- MC-PARAPHRASE   29.    That is, the metal rod takes on a negative charge.
- PARAPHRASE      30.    This pulling toward each other demonstrates that there is a force present and that a field of force has been created.
- MC-PARAPHRASE   31.    This arrangement of atoms may be referred to as an electrostatic field, an electric field, or a dielectric field.
- PARAPHRASE      32.    That is, the two pith balls will repel each other when they have the same charge.

## Appendix C

## Idea Units for Scoring Free-Recall Protocols

Skipping School Idea Units  
Recall Scoring Sheet

1. The boys ran
2. two (boys)
3. until they came to the driveway.
4. "See, I told you
5. today was good
6. said Mark.
7. for skipping choir practice
8. "Mom is never home on Thursday,"
9. he added.
10. "Besides, no one can tell we're here
11. since the tall hedges hide the house
12. (hide) from the road."
13. your place was so big,"
14. Pete (I never knew)
15. as the pair strolled across the yard.
16. finely-landscaped
17. "Yeah, and it's nicer now than it used to be
18. since Dad had
19. the new siding put on
20. stone (siding)
21. and added the fireplace."
22. A permanent underground sprinkler system was in operation
23. as they approached the house.
24. The sprinkler had been installed to keep the lawn going
25. when the weather turned dry.
26. Once they got to the house,
27. Pete peered through the window
28. of the side door
29. which led to the garage.
30. two-car (garage)
31. The garage was empty
32. except for bikes.
33. three 10-speed (bikes)
34. Mark grinned
35. as he opened the side door,
36. explaining that it was always open
37. in case his younger sisters got home earlier than their mother.
38. As they entered,
39. Pete noticed
40. a sign on the door
41. indicating that the family participated
42. in a "neighborhood watch" program
43. which had been organized with the police.

44. Since Pete wanted to see the house,  
45. Mark started with the living room  
46. which, was newly painted.  
47. like the rest of the downstairs  
48. Mark and Pete's  
49. tour stopped for about 20 minutes  
50. as they listened to the new album  
51. Twisted Sister  
52. on the stereo  
53. shiny (stereo)  
54. large (stereo)  
55. in the living room.  
56. The dining room was no place to play,  
57. with all the china,  
58. silver,  
59. and cut glass,  
60. so the boys moved into the kitchen  
61. where they made sandwiches.  
62. Mark said  
63. they wouldn't go to the basement  
64. because it was damp  
65. and musty.  
66. "Dad says  
67. we'll have new plumbing installed  
68. by the end of next month."  
69. Mark said  
70. "This is where my Dad keeps his famous paintings  
71. and his coin collection,"  
72. Dad's valuables in the den  
73. Mark said as they peered into the den.  
74. Mark pointed out  
75. that the local art dealer was constantly asking Mark's  
Dad  
76. to sell the paintings,  
77. which were valued at about \$5000.  
78. Mark bragged  
79. that he could get spending money whenever he needed it  
80. since he'd discovered that his Dad kept a lot  
81. in the desk drawer.  
82. Dad's money  
83. As Mark pulled open the drawer,  
84. Pete's eyes were drawn to the handgun  
85. laying on top of a bunch of papers.  
86. gun in drawer  
87. There were three bedrooms.  
88. upstairs  
89. Pete noticed  
90. that the upper floor was not as new-looking as the  
downstairs.  
91. Mark showed Pete  
92. his mother's closet  
93. which was filled with furs

- \_\_\_\_\_ 94. and the box which held her jewels.
- \_\_\_\_\_ 95. locked (box)
- \_\_\_\_\_ 96. Pete's attention was caught
- \_\_\_\_\_ 97. by the huge, glass sliding door
- \_\_\_\_\_ 98. which looked out over the backyard.
- \_\_\_\_\_ 99. His sisters' room was uninteresting
- \_\_\_\_\_ 100. except for the TV
- \_\_\_\_\_ 101. color (TV)
- \_\_\_\_\_ 102. which Mark carried to his room.
- \_\_\_\_\_ 103. Mark had a room
- \_\_\_\_\_ 104. Mark bragged
- \_\_\_\_\_ 105. that the bathroom in the hall was his
- \_\_\_\_\_ 106. since one had been added
- \_\_\_\_\_ 107. to his sisters room
- \_\_\_\_\_ 108. for their use.
- \_\_\_\_\_ 109. The big highlight in his room, though,
- \_\_\_\_\_ 110. was a leak in the ceiling
- \_\_\_\_\_ 111. where the old roof had finally rotted.
- \_\_\_\_\_ 112. causing leak

Static Electricity - Idea Units  
Recall Scoring Sheet

- \_\_\_\_\_ 1. comb rubbed with cloth
- \_\_\_\_\_ 2. comb rubbed through hair
- \_\_\_\_\_ 3. comb will attract pieces of paper
- \_\_\_\_\_ 4. pieces of paper are light
- \_\_\_\_\_ 5. comb attract paper known for long time
- \_\_\_\_\_ 6. early Greeks knew about it (paper attraction)
- \_\_\_\_\_ 7. without knowing it
- \_\_\_\_\_ 8. Greeks discovered type of electricity
- \_\_\_\_\_ 9. type of electricity today known as static electricity
- \_\_\_\_\_ 10. Greeks knew when they rubbed a piece of amber
- \_\_\_\_\_ 11. amber called elektron
- \_\_\_\_\_ 12. piece of amber rubbed with cloth
- \_\_\_\_\_ 13. amber would attract other objects
- \_\_\_\_\_ 14. object such as cloth
- \_\_\_\_\_ 15. object such as pith
- \_\_\_\_\_ 16. Greek word for amber resulted in English word electron
- \_\_\_\_\_ 17. Greek word for amber resulted in English word  
electricity
- \_\_\_\_\_ 18. originally static electricity considered electricity at  
rest
- \_\_\_\_\_ 19. name "static electricity" implies electricity at rest
- \_\_\_\_\_ 20. since electrons are continually in motion
- \_\_\_\_\_ 21. in motion within the atom
- \_\_\_\_\_ 22. static electricity commonly associated with charged  
bodies
- \_\_\_\_\_ 23. now static electricity commonly associated with charged  
bodies
- \_\_\_\_\_ 24. electrically charged body has more than normal number of  
electrons
- \_\_\_\_\_ 25. electrically charged body has less than normal number of  
electrons
- \_\_\_\_\_ 26. electrically charged body may be positively charged
- \_\_\_\_\_ 27. electrically charged body may be negatively charged
- \_\_\_\_\_ 28. positively charged body has electrons removed from atom
- \_\_\_\_\_ 29. positively charged body has deficiency of electrons
- \_\_\_\_\_ 30. positively charged body has fewer electrons than protons
- \_\_\_\_\_ 31. negatively charged body has more than normal number of  
electrons
- \_\_\_\_\_ 32. negatively charged body has more than normal number (of  
electrons) in each atom
- \_\_\_\_\_ 33. negatively charged body has more electrons than protons
- \_\_\_\_\_ 34. body having equal electrons and protons is uncharged
- \_\_\_\_\_ 35. body having equal electrons and protons is neutral body
- \_\_\_\_\_ 36. removing electrons from body involved physically  
attaching them to another body
- \_\_\_\_\_ 37. other body is moved some distance away
- \_\_\_\_\_ 38. second body will have excess electrons
- \_\_\_\_\_ 39. second body will be negatively charged
- \_\_\_\_\_ 40. first body will have deficiency of electrons
- \_\_\_\_\_ 41. first body will be positively charged
- \_\_\_\_\_ 42. this (charged bodies) illustrated by rubbing glass

- \_\_\_\_\_ 43. rubbing glass with silk
- \_\_\_\_\_ 44. glass and silk then separated
- \_\_\_\_\_ 45. some electrons rubbed off glass
- \_\_\_\_\_ 46. electrons rubbed onto silk
- \_\_\_\_\_ 47. glass left with positive charge
- \_\_\_\_\_ 48. glass left with deficiency of electrons
- \_\_\_\_\_ 49. silk left with negative charge
- \_\_\_\_\_ 50. silk left with excess of electrons
- \_\_\_\_\_ 51. if two bodies are not brought into contact
- \_\_\_\_\_ 52. bodies are silk and glass
- \_\_\_\_\_ 53. they will retain charges
- \_\_\_\_\_ 54. charges retained for long time
- \_\_\_\_\_ 55. charges eventually will leak off
- \_\_\_\_\_ 56. will leak off to surrounding objects
- \_\_\_\_\_ 57. when silk and glass allowed to touch, surplus electrons on silk move onto glass
- \_\_\_\_\_ 58. electrons moving from silk to glass neutralizes charge on two bodies
- \_\_\_\_\_ 59. when rubber rod is rubbed with woolen cloth
- \_\_\_\_\_ 60. rubbing is brisk
- \_\_\_\_\_ 61. electrons from cloth adhere to rubber rod
- \_\_\_\_\_ 62. if two objects separated, excess electrons on rubber rod
  
- \_\_\_\_\_ 63. separated immediately
- \_\_\_\_\_ 64. rubber rod will be negatively charged
- \_\_\_\_\_ 65. glass rod rubbed with wool has negative charge
- \_\_\_\_\_ 66. simple experiment shows effects of two different charges
- \_\_\_\_\_ 67. two balls of pith suspended by thread
- \_\_\_\_\_ 68. ball of pith hang freely
- \_\_\_\_\_ 69. any light material is substituted for pith
- \_\_\_\_\_ 70. if both balls touched with negatively charged rod
- \_\_\_\_\_ 71. if both balls touched with negatively charged rubber rod
- \_\_\_\_\_ 72. balls become negatively charged
- \_\_\_\_\_ 73. balls will swing away from each other
- \_\_\_\_\_ 74. if both balls touched with positively charged rod
- \_\_\_\_\_ 75. if balls touched with positively charged glass rod
- \_\_\_\_\_ 76. balls will swing away from each other (same thing happens)
- \_\_\_\_\_ 77. when both balls charged same way they repel each other
- \_\_\_\_\_ 78. if one ball touched with positively charged rod and the other with negatively charged rod
- \_\_\_\_\_ 79. positive rod is glass
- \_\_\_\_\_ 80. negative rod is rubber
- \_\_\_\_\_ 81. will have unlike charges and will swing toward each other
- \_\_\_\_\_ 82. when two balls have unlike charges will attract
- \_\_\_\_\_ 83. attraction shows force is present
- \_\_\_\_\_ 84. attraction shows field of force has been established
- \_\_\_\_\_ 85. field called electrical field
- \_\_\_\_\_ 86. field called dielectrical field
- \_\_\_\_\_ 87. field called electrostatic field

END